# PUBLIC WORKS


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TEXACO Asphalt on Second Avenue, Pittsburgh, Pa.

*These surroundings—*

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No matter what the character of the street, a TEXACO ASPHALT pavement will in any case meet its requirements. Under the hard knocks of the main business thoroughfare and amid the attractive surroundings of the most exclusive residential section, a TEXACO ASPHALT pavement is equally suitable.

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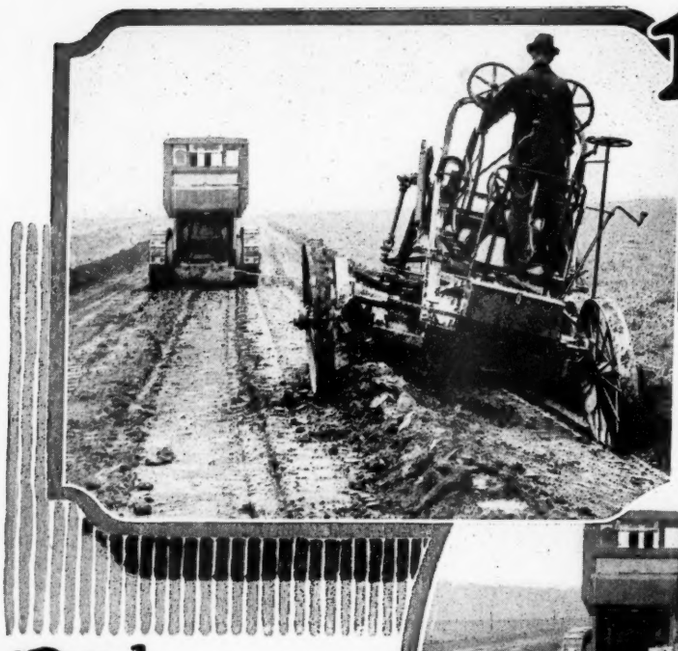
FEBRUARY, 1927



**1st cut** The first or plowing cut is made with the right rear wheel pulled in so that it is directly behind the toe of the blade, which in turn is behind the right front wheel. The left rear wheel is extended to avoid running in the loose dirt.

**2nd cut** In making the second cut the position of the wheels is reversed, the right being extended to brace the machine against the bank while the left is pulled in to run behind the blade and avoid the loose dirt. The only way the operator of a long one-piece axle grader can avoid this loose dirt is by setting the blade at such a sharp angle that the furrow comes inside the left rear wheel, which obviously greatly reduces the amount of work done by his machine.

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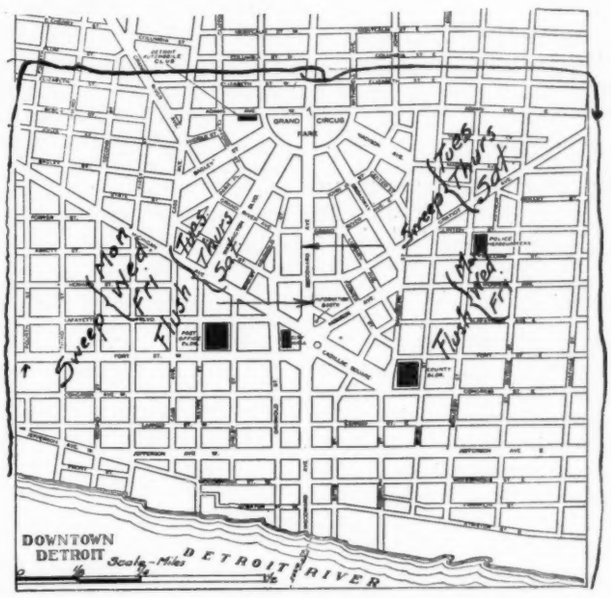
Vol. 58 February, 1927 No. 2

# Down-Town Street Cleaning in Detroit

**Improvements made in methods and equipment during the past two years. Use of flushers, pick-up sweepers, eductors and white wings. Keeping itemized costs.**

By G. R. Thompson *

For the past few years Detroit has depended upon hand labor and flushing for street cleaning in its down-town section and seemed to have reached the conclusion that because of its many automobiles, machine sweeping was impracticable. At one time Detroit had five machine sweepers that operated to a limited extent in the down-town section every night but which were used mostly for cleaning main arterial traffic streets. Two of these sweepers, which had outlived their usefulness for dependable service, were employed on main arteries, and while they were an advantage, their limited accomplishment was neither appreciable nor dependable. A frequent regularity of sweeping within an area seemed to offer more effective results than an equal sweeper mileage spread out over main streets widely separated.




SWEEPING AND FLUSHING SCHEDULE FOR DOWN-TOWN DETROIT

Traffic had become so dense, particularly shipping activities in alleys at rear of commercial buildings, that about two years ago alley collection was shifted from day to night work in the heart of the city. This change resulted in a noticeable improvement in alley cleaning service, which indirectly affected street cleaning, because alley gangs had been depended upon to some extent to assist in street cleaning when delayed by traffic in the alleys. With the elimination of these delays the alley gangs had no time to devote to the streets and the entire burden of hand labor for street cleaning fell onto the white wing forces which threatened to grow beyond reason. As the topography of Detroit is flat, flushers are not effective in cleaning gutters and can be relied upon only to move dirt from the center of the street to the gutter line, where the water runs off, leaving the solid matter to settle in the gutter. Detroit was looking for cleaner streets at less cost and believed they could be obtained better by machine sweeping than by further increase in white wing expenditures.

### PICK-UP SWEEPERS.

It was assumed that a sweeper would operate at $1.25 a mile (20 miles per shift), while white wing labor at $4.40 a day and supplies, for an average half mile beat or one mile of gutter, cost approximately four times as much. The economy of pick-up sweepers seemed apparent. One outstanding factor, however, was debated at considerable length before buying sweepers. This factor was parking. Detroit's liberal parking privileges made it self-evident that down-town sweeping, if at all possible, must be done between midnight and morning. Preliminary night sur-

*Superintendent of the Division of Municipal Waste of Detroit.

NIGHT SWEEPING IN THE DOWNTOWN SECTION

veys of the streets indicated that, while the parked automobile would be a detriment to sweeping, changes in down-town parking regulations might not be immediately necessary. With the assurance that parking would be regulated to accommodate economy and service in street cleaning, the city purchased seven new mechanical pick-up sweepers and is operating two of them satisfactorily in the down-town section, without the passage of further unpopular parking restrictions. It is not implied, however, that parking is not detrimental to street sweeping and it is only in the down-town loop section of Detroit, where cleaning is done on such a frequent schedule, that streets can be kept reasonably clean in spite of parking.

### CLEANING SCHEDULE

The accompanying map is of the down-town so-called loop section of Detroit, which section contains the banking, governmental, retail shopping, theatre and hotel districts. It is this section that Detroit has succeeded in keeping clean mechanically.

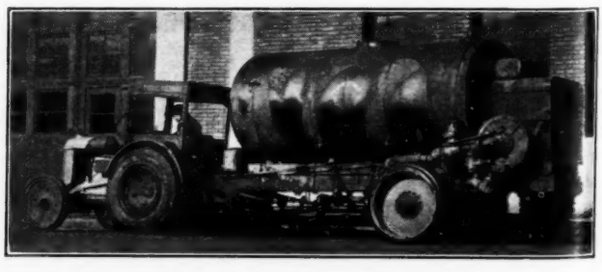
At the beginning of last year's season Detroit employed 38 men on day shift and 12 men on night shift as white wings down-town. With the introduction of sweepers the day force was reduced to 20 men and the night force eliminated. It is to be noted that we still retain white wings and probably always shall, but their duties have changed from streets *cleaning* to what might be termed street *tending*. White wings are located at points of intensive pedestrian traffic to keep such vicinities tidied up free of blowing paper and horse droppings. In making the change over from cleaning by hand to cleaning by machine, no white wings were dropped from the rolls but were transferred to alley collection service, which seemed to be obviously just and reasonable since these men were old in years of age and service. Modern automobile street traffic is unquestionably hazardous to old men, so that the change to alley work was a benefit rather than a hardship to our older white wings.

In the loop section the streets are flushed one night and swept the next, so that every night some street cleaning is performed in the entire loop. Two sweepers and two flushers are used in this area for cleaning. Sweepers leave the garage at 11:00 p. m. completely fueled and adjusted. This pair of sweepers start work from a street intersection, one machine taking the north and south streets while the other does east and west streets. In this way the night work is closely consolidated and the men and equipment engaged therein are in close touch with each other throughout the entire shift.

The lower section of the city along the river containing wholesale houses and factories is swept first, as it may be counted upon to be fairly free of parking during the early hours of the night. On Mondays, Wednesdays and Fridays that portion of the loop west of and including Woodward avenue is swept, and on the alternate night flushed. This half of the loop is divided roughly into three segments, namely, that portion south of Fort street, that portion between Fort and Michigan, and the balance north of Michigan. A similar division is made on the east side, also inclusive of Woodward avenue, which is swept Tuesdays, Thursdays and Saturdays, being flushed on the alternate nights. It is to be noted that this schedule sweeps Woodward avenue every night. To each sweeper is assigned a 1½-ton truck, used during the day on garbage collection. The truck crew consists of a driver, who assists with the loading, and two laborers. It is the duty of the truck crew to keep in touch with their sweeper and to pick up all of its loads, taking same to the Central Transfer Station, over a one-mile haul. It is considered highly important that no piles of street dirt lie over until morning; and because of danger to passing automobiles, street dirt is not dumped on main thoroughfares. Sweeper crews leave the streets at 8:00 a. m. and return to the garage, where the operator is allowed the balance of his shift in which to go over his machine, clean and grease same thoroughly and leave in working order. Flushers work on the same basis.

### FLUSHERS AND EDUCTORS

Flushers are of the two-wheel semi-trailer type of 1,500 gallon capacity and tractor drawn. After two years' use of this type of flusher we believe it more desirable than the truck unit because of lower cost—both initial investment and maintenance—and because with its short turning radius it can operate better on sharp turns and in narrow streets. Three more flushers of this type are on order. As we limit drivers to an



TRAILER-MOUNTED FLUSHER

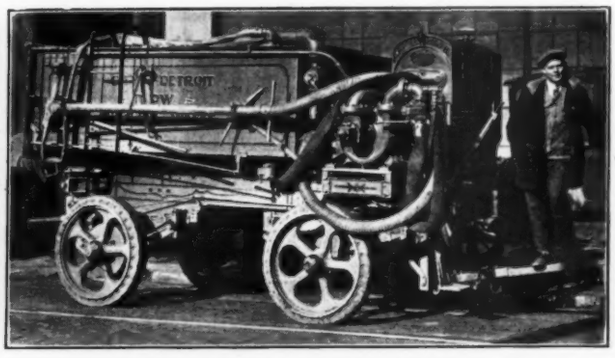
eight mile per hour speed and avoid long dead-head hauls as much as possible, the tractor is at no speed disadvantage with a truck.

Two truck-mounted eductors or catch basin cleaners are used whose work seems to be properly chargeable to street cleaning rather than to sewer cleaning, as is often done. A third eductor tractor drawn and mounted on a four-wheel trailer is now on order. Lower initial and replacement cost seemed to warrant changing from truck mounting to trailer mounting, as in the case of flushers. With cleaner streets there is less dirt to wash into the basins and our two eductors can cover a much larger area than that contained in the loop.

RECORDS

The method in which operating data and costs are kept is shown by the accompanying Equipment Record. Each man employed in the garage or as an operator turns in a time card to the cost clerk, as does the stockkeeper, who gives out parts and supplies. It will be noted that the cost is divided into two main items, namely "Field Operation" and "Repairs." These in turn are reduced to unit cost per mile and per cubic yard. As delays and repairs on this class of equipment may run unduly high, a monthly record is kept of service calls and number of shop repairs on each piece of equipment. On the opposite side of the Equipment Record sheet is given location of work by shifts, together with

TRUCK-MOUNTED EDUCTOR



TRAILER-MOUNTED EDUCTOR

**ESTIMATED COST OF STREET CLEANING—LOOP SECTION**

Interest figured on average value of equipment, and halved on account of double shift on work elsewhere. No charge included for insurance, taxes, license or housing.

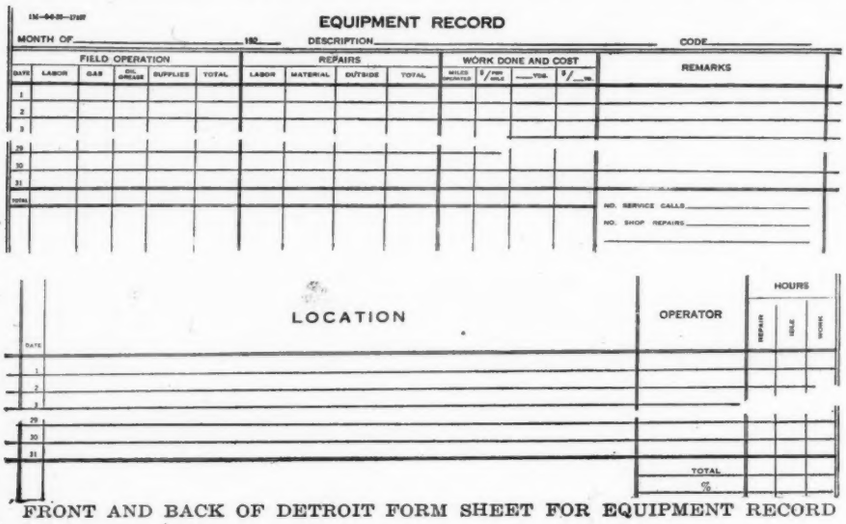
| | 2 Sweepers at $6,500 ea., 200 Days Yr. | 2 Flushers at $5,500 ea., 200 Days Yr. | 2 Eductors at $9,000 ea., 300 Days Yr. | White Wings 365 Days Per Year |
|---|---|---|---|---|
| Int. at 4½% on avg. invest. double shifted. | $146.25 | $123.75 | $202.50 | ..... |
| Depreciation ..... | 20% 2,600.00 | 12½% 1,375.00 | 12½% 2,250.00 | ..... |
| Repairs ..... | 10% 1,300.00 | 5% 550.00 | 5% 900.00 | ..... |
| Broom-renewal, rotary at $40 per 10 shifts. | 1,600.00 | ..... | Tools, supplies | $3,212.00 |
| Broom-renewal, gutter, $16.25, 8 shifts. | 812.50 | ..... | ..... | ..... |
| Gasoline at 15c. gal.. | (28) 840.00 | (66) 1,980.00 | (38) 1,710.00 | ..... |
| Oil-grease: Oil 6c qt. | ( 2) 50.00 | (12) 164.00 | ( 5) 110.00 | ..... |
| Trucks & drivers at $10 per shift ..... | ( 2) 4,000.00 | ..... | ..... | ..... |
| Operator at 75c hour. | ( 2) 3,000.00 | ( 2) 3,000.00 | ( 2) 4,500.00 | ..... |
| Labor at 55c hour... | ( 4) 3,960.00 | ..... | ..... | (20) 32,120.00 |
| Labor at 65c hour.... | ..... | ..... | ( 4) 7,800.00 | *10,950.00 |
| Transfer & dump: 16,000 cu yd at 60c. | 9,600.00 | ..... | ..... | ..... |
| Foreman & car $10.25 per day prorated... | (4/8) 1,025.00 | (2/8) 512.50 | (2/8) 512.50 | (Day) 2,555.00 |
| Total ..... | $28,933.75 | $7,705.25 | $17,984.00 | $48,807.00 |
| 10% supervision and Overhead ..... | 2,893.38 | 770.53 | 1,798.40 | 4,880.70 |
| Grand total..... | $31,827.13 | $8,475.78 | $19,782.40 | $53,687.70 |
| Cost per shift to operate.. | 159.14 | 42.38 | 65.94 | 147.10 |
| St. mi. cleaned, shift.. | .20 | .20 | 1½ | 10.00 |
| Cost per mi. of street..... | 7.96 | 2.14 | 43.95 | 14.70 |
| Frequency of oper't'n | 2 days | 2 days | 40 days | **Daily |
| Cost per mile per day (entire loop)..... | 3.98 | 1.07 | 1,10 | 3.68 |
| 40 miles under cleaning per year..... | 31,827.18 | 8,475.78 | 13,188.00 | 53,687.70 |

*1 yard per man per day at $1.50. **Do not operate over entire loop.

the operator in charge, and this information is reduced monthly to give the percentage of time that the equipment spent in repair, in idleness, and working. The estimated cost of street cleaning in Detroit is given on page 47.

In conclusion, Detroit feels that it is getting cleaner streets by the above outlined methods than it did before it had the street sweepers. Parked automobiles remain a problem that must be solved, not only for street cleaning but for snow removal and many other functions of streets. To this end we anticipate urging further parking regulations. With the addition of increased investment in equipment, greater care and watchfulness is required on the part of operating management to see that this equipment functions to the best advantage.

Millions of dollars are spent annually in this country for street cleaning. Each large city utilizes several methods of doing this work and in each method uses various tools and makes of equipment. As yet no standard uniform system of cost keeping has been established which will enable various cities to interchange statistical data and costs of operation. Since the public through its improvement associations, clubs and commercial organizations is constantly demanding cleaner streets it is essential that the street cleaning industry develop rapidly through interchange of ideas, improved equipment and careful management.


EQUIPMENT RECORD

MONTH OF _____ 192__ DESCRIPTION _____ CODE _____

| DAYS | FIELD OPERATION: LABOR | GAS | OIL, GREASE | SUPPLIES | TOTAL | REPAIRS: LABOR | MATERIAL | OUTSIDE | TOTAL | WORK DONE AND COST: MILES TRAVELED | ¢ PER MILE | ——— TON | ¢/—— YD | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | |
| 29 | | | | | | | | | | | | | | |
| 30 | | | | | | | | | | | | | | |
| 31 | | | | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | | | NO. SERVICE CALLS _____ NO. SHOP REPAIRS _____ |

LOCATION — OPERATOR — HOURS: REPAIR, IDLE, WORK

| DATE | LOCATION | OPERATOR | HOURS: REPAIR | IDLE | WORK |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 29 | | | | | |
| 30 | | | | | |
| 31 | | | | | |
| | | TOTAL | | | |
| | | % | | | |

FRONT AND BACK OF DETROIT FORM SHEET FOR EQUIPMENT RECORD

## Dust Problem on Washington Highways

In his report for the two years ending Sept. 30, 1926, J. W. Hoover, state highway engineer of the State of Washington, under the general head of "Maintenance Work" discusses the dust problems as follows:

"One of the big factors to contend with in maintenance is the dust problem. Traffic is continually increasing and with the advent of the balloon tire the dust conditions are likewise becoming more severe; it is a well known fact that the balloon tire causes more dust than the high pressure one. Also the increased speed at which cars now travel our highways only tends to increase the dust condition. A car equipped with balloon tires and traveling at a high rate of speed not only throws the binder to one side, but stirs up large clouds of dust. To attempt to combat this evil the highway department has been experimenting for the past two years in an effort to find an economical dust preventive. Three methods have been tried out, namely; oiling, sprinkling and the use of calcium chloride. All of these are costly and do not effect a permanent relief. This State is watching with interest the results of oiling as carried on by Oregon and California. It would appear that oiling is more effective in the more arid sections on account of the dry subgrade and road surface."

# Missouri Highway Sanitation*

**By cooperation between State Board of Health and State Highway Commission, safe drinking water, sanitary toilets and comfort stations are being provided at frequent intervals along the highways**

The increase of highway traffic in Missouri, resulting from the use of more automobiles and progress made toward completion of the hard surface road program, is rapidly creating a sanitary condition which demands attention for public health reasons. The large population, from widely scattered localities, traveling the highways during the day and sleeping in tourist camps at night are dependent upon the drinking water and comfort station facilities afforded by the highways. Opportunities for the spread of infection are manifold unless proper supervision of water supplies and sanitation of environment of the highways are maintained. This is a highway problem, necessarily therefore statewide, and should for this reason come under control of the State Board of Health. In Missouri a program of cooperation between the State Board of Health and the State Highway Commission has been initiated, whereby comfort stations are established under private or municipal ownership along the highways.

Missouri's program provides for (1) safe drinking water supplies along the highways at frequent intervals, protected from contamination; (2) sanitary toilets conveniently located; (3) permanent, conspicuous and standard markings to indicate com-

*Abstract of a paper before Iowa Section of American Water Works Association, by W. Scott Johnson, chief sanitary engineer, State Board of Health of Missouri.

fort stations; (4) comfort stations owned and operated largely by private individuals, who are vitally interested in their proper upkeep. The program is positive and not negative in character, since it is the satisfactory comfort stations which receive approval. This feature simplifies the supervision and gives a service of a positive nature to the highway travelers, which meets with greater approval than one of prohibition.

Specifications for comfort stations have been formulated, the stations being classified as grade A, grade B and grade C. The grade A stations must meet the following requirements:

*Water Supply*

1. All grade A comfort stations shall have conveniently available a safe drinking water supply free from sanitary defects and conforming to the standards of the United States Public Health Service.
2. Individual paper drinking cups shall be provided.
3. No common drinking cup or glass shall be permitted.

*Toilets*

1. Two toilet rooms shall be provided, separate for men and women.
2. A minimum of one each of the following plumbing fixtures shall be provided for each toilet:
   a—Water closet bowl with impervious seat and closet tank.
   b—White enamel wash basins; liquid soap container.
   c—Suitable holder for individual or paper towels and receptacle for used towels. No common towel shall be permitted.
3. The sewage shall be disposed of in a sanitary and approved manner.
4. The building and fixtures shall be kept clean and sanitary at all times.

For Grade B Stations, items 1, 2 and 3 under "water supply" and item 1 under "toilets" are the same. The additional items are: 2—A minimum of one chemical toilet shall be provided for each toilet room. 3—A wash basin, supply of water, soap and individual paper towels shall be provided. 4—The building and fixtures shall be kept clean and sanitary at all times.

For Grade C Comfort Station, items 1 and 3 under water supply are the same as for Grade A. (Item 2 is omitted). The other provisions are under the head of "Toilets": 1—Two sanitary pits, or other approved type, outdoor toilets shall be provided, separated for men and women. 2—These shall be constructed, maintained and operated in accordance with the principles outlined in bulletin No. 20, State Board of Health of Missouri.

While Grade A stations are being urged wherever possible and will be practically the only type along the more important routes, there will be for the present a large number of B and C types along the less important highways.

The Division of Sanitary Engineering of the State Board of Health has made a field survey of all places along the national highways in Missouri which are interested in complying with these specifications and are adaptable by location for this purpose. The survey of the water supply takes into consideration the location as regards possible sources of pollution; the construction of well or cistern, including type and condition of walls or casing, design and condition of pump, surface protection and other features which influence the safety of the water supply; and bacteriological examination of a sample; samples for bacterial analysis being collected only from those supplies which a field survey shows to be properly protected.

If this inspection, or later inspection following designated improvements, shows that the comfort station meets with the State Board of Health requirements, the Highway Department is notified and a standard sign is placed on the right of way and a certificate of approval is issued to the station indicating that the conditions meet the State Board of Health specifications for an approved comfort station and the grade of same. Several inspections will be made each year of the approved comfort stations, including periodic bacterial examination of the water supply.

Standard signs will also be used at city limits to inform the tourist with regard to the safety of the city water supply where such supplies exist. The program also includes the survey of city tourist camps and recommendations for changes necessary to meet the specifications for an approved highway rest station. The approval signs used are similar to the national highway signs recommended as standard for all national highways.

The filling stations, garages, tourist camps and stores where food can be obtained, which have multiplied with increased highway traffic, have shown

STANDARD DRINKING WATER SIGN

exceptional interest in the program for comfort stations and a large number have already started or completed improvements to comply with the Board's specification.

Since last February one man's entire time has been spent covering 2,750 miles of national highways in a car, supervising this program. During this period 591 inspections were made of 325 comfort stations and reinspections of 209 of them. Of the water supplies for these stations, 231 were found to come from privately owned wells or cisterns, and 102 from municipal water supplies. Of the former, 90 have been improved to meet the specifications. Municipal water supplies were satisfactory except in 4 instances. Of 340 comfort stations, 55 are served by city sewers, 62 by septic tanks, 21 by chemical toilets, and the remaining 202 by privies. A total of 81 stations have improved toilet facilities to meet the specifications which, in addition to those already satisfactory, brings the total number of comfort stations with sanitary toilets to 198. Complete improvements according to class A specifications have been secured at 39 comfort stations or 12 per cent of those inspected, and these have received certifi-

cates and been approved for the highway sign. Many have made decided improvements but have failed to meet all the requirements.

It is believed that this work will have an indirect result in improving conditions in rural communities. A general program of sanitation of rural communities, although greatly needed, would require a considerable increase in personnel of the present State Board of Health. The establishment of safe water supplies and sanitary toilets at comfort stations will constitute a constant demonstration in sanitation to the surrounding community and unquestionably an influence for better conditions in general.

## Garbage Disposal in Chicago

During the year 1925, the latest for which the annual reports are available, the municipal reduction plant of Chicago received and disposed of 101,905 tons of raw garbage, as compared with 113,596 tons during the previous year, a decrease of 10.3 per cent.

The production of garbage grease during the year totaled a little over 6,000,000 pounds, a decrease of 6 per cent from the production of 1924. Better prices were received, however, with the result that the revenue derived from garbage bones, rags and scrap iron, totaled $394,504, as compared with $333,383 the previous year.

Owing to higher wages and costs of other materials, presumably, the total operating expenditures during 1925 somewhat exceeded those of 1924. Salaries and wages were $450,868, as compared to $427,143 in 1924. The other items, fuel oil, power and light, coal, removal of dried garbage and rubbish, all slightly exceeded the total for 1924, but the total for supplies and repairs were slightly less. The total expenditure was $710,023, as compared with $694,845 in 1924.

The unit costs of operation per ton of raw garbage were as follows. Salaries and wages, $4.42; fuel oil, $0.680; power and light, $0.186; coal, $0.448; supplies and repairs, $0.972; removal of dried garbage and rubbish, $0.257. This gives a total cost per ton of raw garbage during 1925 of $6.967, as compared with $6.117 in 1924.

The difference between the operating expenditure—$710,023—and the revenue from the sale of grease and other products—$394,504, is the net cost of disposing of the waste, or $3.07 a ton. This includes no charge for collection nor anything for interest and depreciation of plant or other overhead charges.

# Recent Results From Separate Sludge Digestion Experiments*

**Conducted by the New Jersey Agricultural Experiment Station and the Plainfield Sewage Disposal Plant.**

By Willem Rudolfs †

### INTRODUCTION

Considerable experimentation both in the laboratory and at the plant showed a possible way to relieve conditions at Plainfield and John R. Downes, superintendent of the Plainfield Sewage Disposal Plant, built a square earthen separate sludge digestion tank, of 25,000 cubic feet capacity, which was covered with a floating wooden cover. The cover was constructed in such a way that it fitted rather closely to the walls, the object being to keep submerged the scum formed to insure better anaerobic digestion and to prevent the escape of gases and odors. In the middle of the cover an opening was left, over which a square sheet-iron box was placed for the collection of gases. This tank was preliminary in character. After sufficient data on the digestion of the sludge had been obtained, the superintendent built two 16-sided concrete tanks, supplied with floating covers and facilities for adjusting the fresh solids with lime and for heating the sludge.

### PROCEDURE

Previous to August 20, 1925, 5,500 cubic feet of ripe sludge was pumped into the tank from the Imhoff tanks for seeding. Fresh solids were added every two or three days up to October 16 and our experiments were begun at the latter date. The fresh solids were obtained from an Imhoff tank which was used as a preliminary settling tank. These fresh solids were adjusted with dry hydrated lime to a pH value of 7.3.

The amount of gas, the composition of the gas, the pH values, the total acidity, the total alkalinity, the $NH_3$-nitrogen, the solids and the ash were determined. Bacteriological and zoological counts were made and an automatic record was kept of the temperature in the tank and of the air.

### RESULTS

Our laboratory determinations were begun after the tank had been in operation for 60 days. During the two months proceeding the laboratory determinations, the tank had a chance to come

*Paper No. 323 of the Journal Series, New Jersey Agricultural Experiment Station, Department of Sewage Disposal, presented before the American Society for Municipal Improvements.

†Chief, Department of Sewage Disposal, New Jersey Agricultural Experiment Station.

to a certain equilibrium, and our determinations started at a time when possible initial difficulties in operation were adjusted, although the time of the year was least fitted to obtain maximum results. All our determinations were made on the liquid between sludge and scum and on the sludge itself. We had found previously that in Imhoff tanks the liquid gave a true indication of the activities in the tank and the same held true for the liquid in the separate sludge digestion tank. If provisions are made to draw sludge from not too near the bottom of a separate sludge tank I would favor determinations on the sludge, but in case the sludge outlet is at the bottom or reaches only partly down into the tank, sampling from the liquid layer would give a better index of activities. When new separate sludge digestion tanks are built, it might be well to have outlets at different depths. This would allow for the withdrawal of liquid (sludge concentration) and for sampling at different levels. When it is desired to determine the trend of activities in the tank, samples of the liquid should be taken about 1 to 1½ feet above the sludge level.

The laboratory determinations, begun October 16, lasted for a period of about 180 days (six months), samples being taken three times a week. The total addition of fresh solids was 96,300 cubic feet (95% moisture). The amount of material present in the tank when the experiment was started was about 15,000 cubic feet (92.3% moisture) comparable to 23,000 cubic feet of 5% solids sludge. The rate of addition of fresh solids on a daily basis was 2.3% (dry solids).

At the beginning of the experiment, the total acidity was generally higher than during the latter part and the pH values of the tank material only a few times reached 7.3 (usually 7.1 to 7.2); but during the second half the pH value was practically always 7.3 or slightly above. The trend of the alkalinity curves could naturally be related directly to the pH values, but the curve for the carbondioxide content of the gas was in general inversely proportional to the pH values. With a low pH value, carbondioxide was high, and with a higher pH value, this component of the gas was low.

The curves constructed for the ammonia nitrogen content were in general directly related to the addition of fresh solids. However, the increases in ammonia content were usually slightly behind the additions of fresh solids and with the accumulations of fresh solids, ammonia increased. This was to be expected, since decomposition of nitrogenous materials follows the breaking down of soluble and easily destroyed carbohydrate material.

The ash content of sludge in the tank was 37.7% at the beginning; the ash content of the fresh solids varied between 22 and 24%; whereas the average ash content of the material in the tank during the whole period was 37.4%. There was therefore an average ash increase of the fresh solids of at least 50% in the course of digestion.

When it was assumed that the sludge in the tank at the end of the gas measurements was in the same stage of decomposition as at the beginning of the experiment (all figures bear out this assumption) and when the fresh solids added were taken as a basis for comparison, it was found that 3.74 cubic feet gas was produced per cubic foot fresh solids (95% moisture). The gas production calculated on a basis of dry fresh solids, was 72.5 cubic feet per cubic foot dry solids. Only part of the organic matter was destroyed, since it is impractical to carry the decomposition to completion. It must be emphasized that the tank was by no means gas tight and gas was escaping continuously through small cracks and along the edges. The quantity of gas produced—leaving aside loss—from material in the tank was considerably below the quantities obtained in carefully controlled laboratory experiments. The possible amount of gas produced from material carried to complete digestion is at least 250 cubic feet per cubic foot dry organic material. In this experiment, approximately 100 cubic feet per cubic foot organic matter was obtained. Since the possible gas production from material brought to complete digestion (under usual circumstances prevailing in good working tanks) is from 250 to 350 cubic feet per cubic foot organic matter, it would seem that during the period of gas measurements an equivalent of from 30 to 40% fresh solids added was digested (gassified). The gassification figures indicate a quantity of fresh solids digested considerably lower than the results show on the basis of solids reduction. In a previous publication* we have drawn attention to the fact that under certain conditions liquefaction can be induced. The laboratory experiments show that a pH value of 7.3, liquefaction overbalances gassification. Therefore it is evident that liquefaction took place in addition to gassification and the tank performed better than the figures on gassification tend to show.

The temperature of the tank contents, determined approximately half way between top and bottom of the tank, dropped gradually from 68°F in October to about 50°F in the middle of February. The temperature then remained stationary and on February 22nd hot water was pumped through a coil for the purpose of heating the sludge. No fresh solids were introduced and four days later the temperature began to rise. While the tank was being heated the superintendent kept a careful record of the amount of soft coal used. The experiment was continued for 30 days and from his records he calculated that it took one pound of coal per day to heat 1,000 pounds of material 13°F, or in other words one pound of soft coal per day raised 1,000 pounds of sludge 0.4° per day. The tank was well insulated and moreover our automatic records show that the air temperature was always lower than the temperature of the tank contents.

It has been mentioned above that the fresh solids were added every 2 or 3 days. This made storage of fresh solids in the sedimentation tank necessary and resulted in considerable acid pro-

*N. J. Agr. Expt. Sta. Bull. 427.

duction. The amount of hydrated lime added to the fresh solids to obtain pH values of 7.3 amounted to 71 grams per cubic foot fresh solids. According to our laboratory experiments, when fresh solids are added every day, the amount of lime should have been less than half of that used. If these same fresh solids had been stored for a period of 7 to 10 days before addition to the digestion tank the amount of lime necessary would have been at least doubled.

The results obtained on the bacteriological part of this experiment showed similar fluctuations and an establishment of an equilibrium as has been previously reported from our laboratory experiments. The significant fact is that when conditions were good for digestion, as indicated by low carbon dioxide and high methane content together with relative high alkalinity, the numbers of total bacteria were low, whereas when the conditions for digestion were unfavorable, as judged by increasing carbon dioxide and decreasing methane content of the gas and decreasing alkalinity, the numbers of total bacteria showed an increased stimulation accompanied by a high average of lactose fermenting organisms. It has previously been concluded that conditions for favorable digestion are indicated by a low, uniform level of bacterial numbers.

The protozoan fauna was in general low and could be compared directly with the kind and numbers of animals found in the digestion compartment of an Imhoff tank. Only once during the half year of observation did the protozoa count rise above 100,000 per cc. It will be remembered that our zoologist has pointed out frequently that high numbers of protozoa in the digestion chamber is a good indication of poor working conditions.

It is of interest to compare the general efficiency in the digestion of sludge in an Imhoff tank and in this covered separate sludge digestion tank. Roughly the covered separate sludge tank digested satisfactorily 100,000 cubic feet of fresh solids (95% moisture) during 180 days in winter at an average temperature of 55.5°F. The quantity of fresh solids added was equivalent to 555 cubic feet, or 1734 pounds, per day on a dry basis. Using the graph of Mr. Downes presented by him in the discussion of Mr. Eddy's paper on the "Behavior of Imhoff tanks,"* we find that the 25,000 cubic feet capacity of the tanks was equivalent to 100 days of accumulation of sludge in the various stages of digestion. The theoretical advantage of raising the slot of an Imhoff tank so as to increase the effective sludge storage space to 150 days has been shown by Downes† to be insufficient for Plainfield. However, calculations made in our laboratory showed that this tank had received more fresh solids than it could handle properly. It seems nevertheless fair to assume that at least 100 days sludge storage capacity is required for good working Imhoff tanks and since the covered separate sludge tank had an equivalent to 100 days sludge storage, it might be concluded that this tank did as well as a good working Imhoff tank. However, this does not mean that the ultimate capacity of the separate sludge digestion tank was reached because: (1)—the fresh solids were added to the tank as the need for space arose rather than to the necessary addition to keep the relation between ripe sludge and fresh solids as nearly correct as possible, or, in other words, to hold the biological equilibrium at an optimum and (2)—Mr. Downes' calculations for an Imhoff tank were based on summer temperature, whereas the results obtained with the separate sludge digestion tank were accomplished during the winter months.

If we assume that the correction of the reaction of the fresh solids by the addition of lime compensated for the higher temperature in summer, we still find that the separate sludge digestion tank was as effective as a good working Imhoff tank. This assumption is very unfair to the separate sludge digestion tank, since a good working Imhoff tank does not receive more fresh solids than it can handle, and reaction adjustment would be rarely necessary. The same holds for a separate sludge digestion tank, provided the fresh solids are really fresh when added and the biological equilibrium is not upset.

It appears thus that with proper handling no greater sludge capacity will be necessary for separate sludge digestion tanks than for Imhoff tanks.

Whether Imhoff tanks or separate sludge digestion tanks are to be used will depend upon their cost (construction and operating), on their flexibility, and on their ease of control. The reaction of tank contents is an important factor in digestion and appears to be controlled with a greater degree of accuracy in separate sludge tanks. The daily addition of *definite* quantities of fresh solids to ripe sludge seems simpler in separate sludge digestion tanks than in Imhoff tanks. Submergence of scum by weighing down and the collection of gases will be equally feasible in both types of tanks, but it seems easier and certainly more economical to apply heat to the sludge to be digested in a separate sludge digestion tank than to the sludge of an Imhoff tank.

## CONCLUSIONS

The following conclusions might be drawn:

1. Since it was possible with 1 pound of soft coal per 1,000 pounds of sludge to raise the temperature of the sludge 0.4°F per day, it probably will cost less to *maintain* a higher temperature when heating is begun as soon as the temperature drops.

2. If really fresh solids are added every day, the amount of lime necessary for adjustment will be small because the material in the tank in a proper biological balance condition will maintain an optimum reaction for digestion.

3. A properly insulated separate digestion tank under good control is at least as efficient as an Imhoff tank; consequently sludge digestion capacity will be about equal for both types of tanks.

*Trans. Amer. Soc. Civ. Eng., v. 58, pp. 465-510.
†Public Works, v. 54, p. 363-365.

# Lining and Covering Quincy Reservoir*

**Old reservoir forty-five years old with wooden roof reconstructed with concrete cover and roof. Details of design and of construction methods. Handling concrete materials and forms.**

By Paul Hansen†

The city of Quincy has, during the past year, provided a concrete lining and cover for an equalizing reservoir on the distribution system having a capacity of approximately 20 million gallons. The undertaking is of interest on account of its magnitude, certain features of design, the rapidity and system with which it was built, and on account of the proposed use of the top for tennis courts. It is also interesting to note that, although the reservoir is exceptionally large as compared with the quantity of water pumped daily, namely about 5 million gallons, the city considered this volume of elevated storage of sufficient value to fully warrant the expenditure of placing it under cover.

A very brief description of the existing water works will make clearer the relation of the equalizing reservoir to the rest of the water works.

The supply is taken from the Mississippi river through an intake as remote from local pollution as possible. The water is pumped by means of low lift, electrically driven centrifugal pumps to a filter plant having a nominal capacity of 6 million gallons per twenty-four hours. The water from the filter plant enters a clear water reservoir under the filters with a capacity of about 100,000 gallons and this storage in turn is supplemented at the same elevation by a recently constructed circular concrete reservoir of about three-quarters of a million gallons capacity. The water from these reservoirs is lifted by two electrically driven centrifugal pumps into the distribution system. The excess of pumpage over consumption enters the large equalizing reservoir and becomes available when consumption is in excess of pumpage. At normal rates of consumption the equalizing reservoir has a supply that will last the city approximately four days. Near the equalizing reservoir is a small section of the city that can not be served by gravity from the reservoir. This section is served by a high service distribution system supplied by a small electrically equipped pumping station taking water from the mains near the large reservoir. An elevated tank of about 300,000 gallons capacity adjoining the pumping station serves to equalize pressure on the high service distribution system.

The large equalizing reservoir has a capacity sufficient to meet any reasonable fire emergency without assistance from the pumps. It also has a capacity to tide over any break-down of the pumps likely to occur. It is not necessary to maintain standby equipment, although the old steam pumping equipment and boilers are still available for standby service. It is not the practice, however, to maintain fires under the boilers.

The availability of the equalizing reservoir permits the city to obtain favorable power rates for all pumping can be done by a single pump operating at a uniform rate and on an off-peak load. The current is obtained from the hydro-electric development at Keokuk.

The original equalizing reservoir was constructed in 1881-82 and consisted of an open basin 424 feet long by 328 feet wide at top of inside slopes of embank-

* Paper before the Illinois Section of the American Water Works Association.

† Pearse, Greeley and Hansen, Engineers, Chicago.

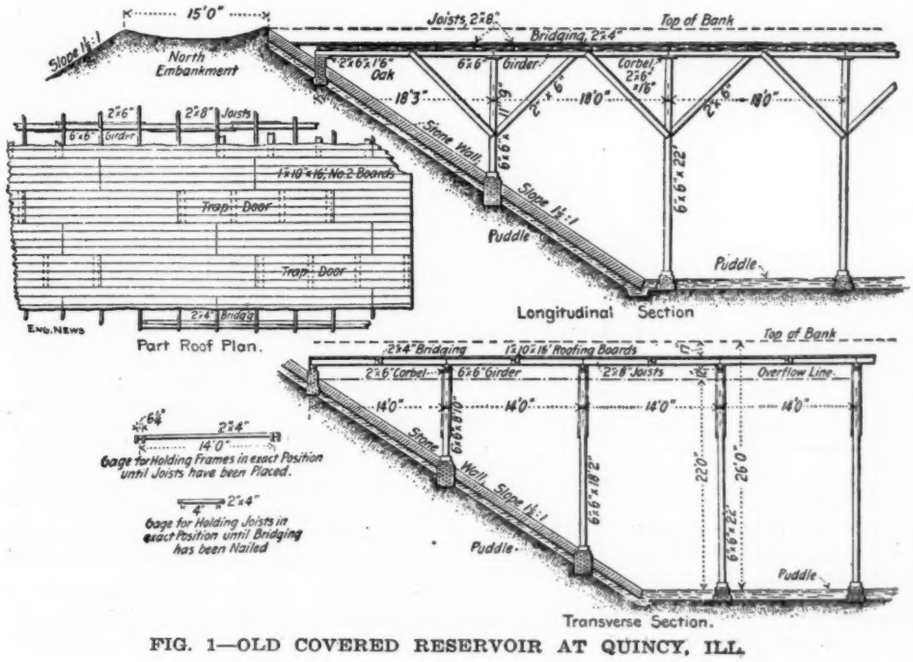



FIG. 1—OLD COVERED RESERVOIR AT QUINCY, ILL.

ments and about 25 feet deep, the embankments having slopes, both inside and outside of two on one. The embankments were made of materials excavated within the reservoir. The outside slopes were sodded and the inside slopes were paved with limestone placed on 9 inches of clay puddle. The bottom was covered with about 12 inches of clay puddle.

Trouble developed on account of algal growths in the clear filtered water that was delivered to the reservoir. To overcome this the reservoir was covered in 1898 with a roof of white pine supported on 6 inch x 6 inch x 12 foot posts, the posts in turn being supported on short brick piers. All posts were given two coats of preservatives. This covering deteriorated and had to be removed in 1905 or seven years after it was built.

The practice of treating the water with copper sulphate was started in 1907 and continued until the reservoir was put out of service in June 1925 to permit the new construction. Copper sulphate did not, however, prove completely effective in keeping down the algal growths, and, moreover, there was the danger of miscellaneous contamination that might be thrown into the reservoir by mischievous or careless people. In the latter part of 1924 a complete concrete cover and lining was authorized by a large favorable popular vote on a bond issue, which bond issue was predicated on plans prepared by Pearse, Greeley and Hansen. Bids were taken for the work on May 28, 1925 and the contract was awarded to the Priester Construction Co. of Davenport, Iowa at an estimated cost of $174,578. Sixteen contractors in all submitted bids for this work.

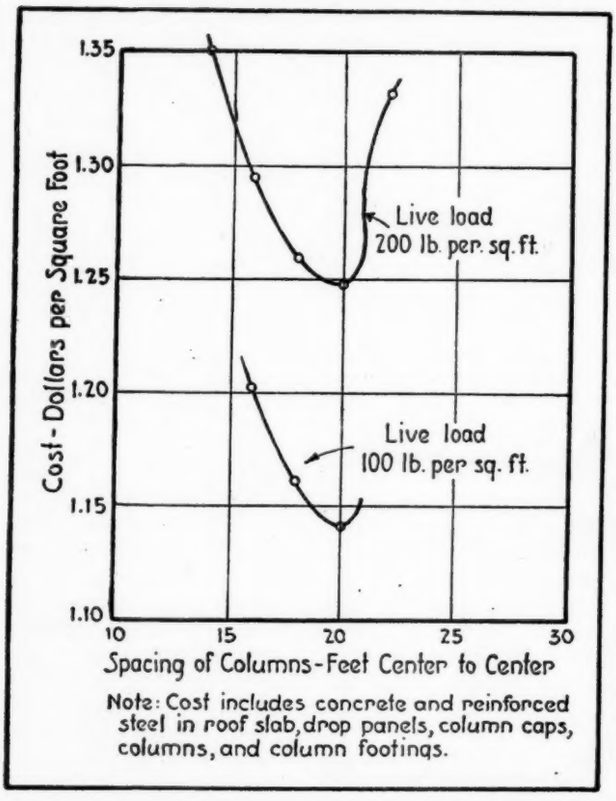



FIG. 2—TOTAL COST OF RESERVOIR PER SQUARE FOOT FOR VARIOUS COLUMN SPACINGS

In designing the new construction, special effort was made to have as many repeated details as possible so as to permit the maximum re-use of forms. Care was also taken to have the design such as to simplify the form work as much as practicable.

The question of absolute water tightness was not important for the embankments had, during many years, demonstrated their capacity to hold water. Accordingly the floor and sides were made up of 6-inch paving placed in a single layer. In providing expansion joints, an arrangement was used which would permit the column footings to move independently of the floor paving inasmuch as it was anticipated that there might be a slight difference in the amount of settlement between the columns and the paving. This actually developed to be the case. The roof is of the flat slap type of construction. It is typical of construction of this character and involves no especially novel features. The roof was made strong enough to support a live load of 200 pounds per square foot, which included an average covering of 12 inches of earth. The slab thickness was made eight inches and the design was based on 650 pounds per square inch compressive strength in concrete and 16,000 pounds per square inch tensile strength in the reinforcing steel. The earth covering was used to protect the roof structure from undue expansion and contraction and to provide a better surface upon which to construct tennis courts. It also makes possible the growth of grass and shrubbery between and around the tennis courts, thus adding materially to the appearance.

A curb was needed around the top of the embankment to support the roof slabs. Advantage was taken of this to increase the capacity of the reservoir by some 2,000,000 gallons, making the total capacity about 20,000,000 gallons by merely making the curb and columns somewhat higher than needed for structural reasons at relatively small expense.

Alternate designs were studied using a series of column spacings varying from 14 to 22 feet center to center. It developed that 20-foot spacing of columns was the most economical (See figure 2.)

A problem in drainage was presented by the covering of the reservoir. The original embankments are of a clayey material which has a tendency to slough when saturated with water. Prior to the placing of the covering on the reservoir, so little water reached the outside slopes from rainfall on the top and slopes of the embankment that it rarely became saturated enough to have any tendency to slough. With the new covering in place, however, large quantities of rain falling on the covering must be taken care of, so it will not flow over the embankments and erode them or saturate them and cause them to slough. Such sloughing actually occurred during the progress of construction, illustrating the new danger to the embankments.

To overcome this danger, a gutter was placed around the entire periphery of the top of the reservoir and so arranged as to convey storm water to several points where it may be safely lead to street gutters or storm sewers by means of pipes.

The inlet and outlet arrangements are so designed as to provide a good circulation of water in the reservoir. There is only one connection to the mains. From this there was laid a header pipe on the floor of the reservoir and extending to the opposite end. At intervals of 120 feet there are three lines of smaller pipe extending to points near the sides of the reservoir and at right angles to the main header. The ends of the laterals are provided with check valves. On one side of the reservoir the check valves open outward and on the other side they open inward. Therefore the entering water will be admitted to one side of the reservoir and withdrawn from the other. The main header and laterals are so proportioned in size as to create approximately the same friction losses to each of the inlet check valves and each of the outlet check valves.

Inside the reservoir are placed pressure pipes furnished with water from the high level distribution system of the city for the purpose of cleaning the inside of the reservoir.

Ventilation is furnished within the reservoir by two ventilating houses, one at either end of the reservoir. One of the houses also provides means of access to the reservoir. They have been given architectural treatment which renders them pleasing in appearance. There are also a number of manholes in the top of the reservoir which will admit light and air and provide access at any time that the reservoir may be emptied for repairs or cleaning. These manholes are provided with lock down covers so that they cannot be opened by unauthorized persons and they are so designed that surface drainage cannot enter.

Some consideration was given in the design of the reservoir to the installation of a division wall which would create two independent basins, but the rather large expense involved for such a division wall was not deemed warranted under local conditions. In the first place, the reservoir will hold clear water only, so that it will have to be emptied for cleansing purposes at very rare intervals. It is also quite improbable that any break will occur which will require the emptying of the reservoir for repair purposes. Even if this should be the case, it is always possible to start up the steam pumping equipment to keep the city in an adequate supply of water when the reservoir is emptied.

The contractors began work on June 8 and completed the contract 32.3 days in advance of the time allowed for the completion of the work and thus became entitled to a bonus of $3230, or at the rate of $100 per day. The work of the contractors was very carefully planned and with very few exceptions was carried out very closely on schedule. Practically the only exception was caused by some delays in the delivery of reinforcing steel for the roof and by weather conditions.

In arranging their plant, the contractors took advantage of the existing reservoir embankment. Sand and gravel bins were erected on the outside of the east embankment of the reservoir and a truck ramp was built on the embankment so that the trucks carrying materials could drive directly to the top of the embankment and dump sand and gravel into bins. From the bins the sand and gravel was permitted to flow by gravity through suitable gates into batch measuring cars. These cars operated on an inclined railway to a point above the level of the concrete mixers located at the top of the embankment. The cement was stored in a building at the base of the embankment along side the railway for the batch cars and was handled by hand into the batch cars. This constituted practically the entire hand handling of materials about the contractors' plant. The finished concrete was dumped into elevators which carried the concrete to a tower 140 feet high equipped with an Insley spouting system. The spouts discharged into hopper shaped receivers as close to points where concrete was being placed as practicable. The receivers in turn discharged into concrete buggies which were pushed by hand to wherever concreting was being done. The receivers served to re-mix the concrete after its passage down the chutes thus preventing segregation of materials in the concrete as placed.

The work of building the reservoir proceeded generally in the following manner. Column footings were poured first, then a section of side slope or floor around these footings was poured. Next the columns were poured and finally the roof slab. The work was so planned that it proceeded from the east side of the reservoir to the west side, keeping the footings and floor columns enough in advance of the roof slab so that carpenters could be kept busy on shoring and forms for the roof continuously. The earth removed

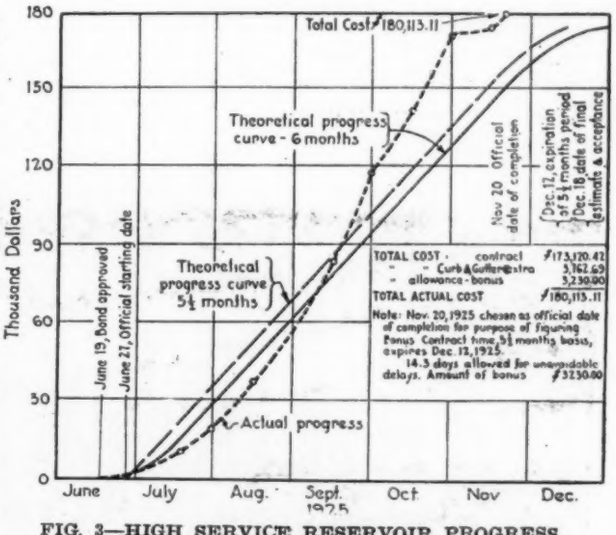



FIG. 3—HIGH SERVICE RESERVOIR PROGRESS CHART

from the bottom of the reservoir was placed in a pile on the west side of the bottom area and stored there until the roof was sufficiently seasoned to permit spreading it thereon. In this way a minimum handling of earth resulted.

The roof slab and drop panels at column heads were supported by 4 inch x 4 inch shores and 2 inch x 6 inch stringers. The stringers rested on steel clamps bolted to the shores. These clamps were made of short pieces of angle iron containing a curved slotted hole. They were bolted at the correct height with the bolt in the bottom of the curved slot. When ready to remove panel forms, the bolt was loosened and the clamp allowed to drop about 1½ inches. This allowed the stringers and panels to be readily removed and carried ahead. It also prevented injury to the forms on account of nails. Where nails were required to support the cross bracing for the shoring a special type of nail with a collar was used so that it could not be driven flush. Thus it was possible to remove the nails readily and with minimum damage to the lumber. Forms were removed from beneath the roof slab in ten days, but the shoring remained in place for twenty-one days after the concrete was poured. Concrete was 1:2:4 mix to which 5 pounds of lime were added for each bag of cement. All construction joints in the roof slab were made in the centers of panels. The reinforcing steel came on the work cut to lengths and bent as required.

As the work consisted largely of repetition of operations, the men became very expert in placing forms, pouring concrete, removing forms, etc., and progress was rapid and satisfactory. Figure 3 is a chart showing the progress rate on the work as compared with the theoretical progress curve on a five and one-half and six months basis. The curve of actual progress shows how the rate of progress accelerated during the first months. At the end is noted the inevitable slowing down incident to the final adjustment of details common on all construction work.

W. R. Gelston, superintendent of water works, was of very great assistance throughout the work and offered many valuable suggestions with reference to both design and construction. Preparation of detail designs for this work were under the immediate direction of R. S. Rankin. General supervision over construction was under the direction of J. K. Giesey. J. R. Longley was tempo- Mr. Longley was succeeded by W. A. Turner who remained as resident engineer from June 27 to October 18. Mr. Turner in turn was replaced by K. V. Hill who supervised the work to completion. The contract, as noted, was handled by the Priester Construction Co., with J. C. Tunicliffe in direct charge.

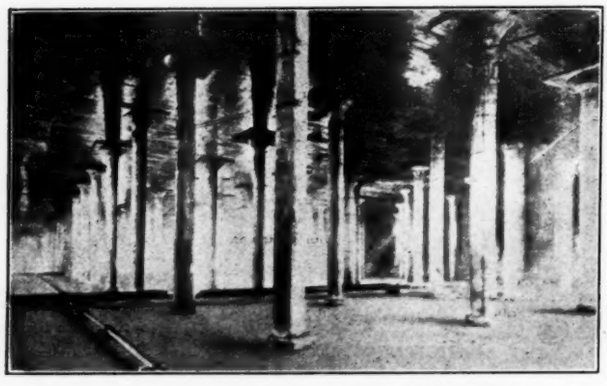


FIG. 4—GENERAL VIEW OF RESERVOIR

# Water Main Leakage in Chicago

**Work done and procedure followed by Water Pipe Extension Division. Results obtained from 1907 to date.**

The water pipe extension division of the Department of Public Works of Chicago is continually employed, among other services, in endeavoring to locate and stop leakage in underground mains. During 1925 tests were made of 55.75 miles of pipe in streets which were about to be paved, and the mains, hydrants and valves placed in a first-class condition before the paving work began. This class of work totaled about 602 miles from 1916 to 1925 inclusive, which is 18.4 percent of the total mileage in service at the end of 1925.

The latest annual report of the engineer of the Department of Public Works contains the following review of the water surveys made by the engineers of the water pipe extension division from 1907 to and including the year 1925.

Surveys to determine what was becoming of Chicago's water were started in 1907 by a section of the Water Pipe Extension Division called the Division of Water Surveys. The work done from 1907 to 1912, inclusive, covered about one-third of the area of the city—from Fullerton Ave. on the north to 63rd st. on the south, and as far west as Kedzie Ave. These surveys had for their objects the determination of the distribution of the consumption, and the detection of underground leakage in the street and the elimination of plumbing leakage and willful waste. The first step towards these ends was to determine how much water was really being pumped. Pump slippage was found to account for about 15 per cent of the water at the beginning of the surveys. Reports of these tests furnished information which enabled the Operating Division to keep their pumps in much better condition. Tests of pumping engines are now made at least every five weeks and the slip is kept down to about 3 per cent.

To carry out the work of determining the distribution of the water consumption, districts of from 70 to 360 acres were surveyed. They were selected according to the character of the water consumption as it was essential to classify the same where possible. In laying out a district for investigation it was necessary to determine

the water mains which were to supply the district with water during the test. They had to be adequate to maintain a normal pressure throughout the district under test and to provide against the emergency of fires.

When the area to be surveyed was defined, the valves along the boundary of the district were closed, and a pitometer was installed on the supply main feeding the district. A continuous record was made for a period of about seven days. From this test the average daily consumption of the district was determined and also the rate of consumption during the night time when the use of water is normally at a minimum. Where the rates were high or abnormal a second test was made, called a subdivision test, to localize the flow.

Efforts were made to reduce the waste and plumbing leakage by house to house inspections and plumbing repairs in territories where a high daily rate of consumption was found. Plumbing inspectors were sent into the premises to inspect all plumbing fixtures and notices were sent to the owners to make plumbing repairs. After the plumbing fixtures had been repaired, a second survey was made to determine the reduction in the rate of consumption, and in all the districts resurveyed it was found that the water consumption had been reduced considerably, sometimes by one-half. It was found also that after a period of about one year the conditions were as bad as previous to the plumbing inspection and repair. It was thus shown that plumbing leakage and willful waste could not be permanently stopped by this method of survey without great expense, and it was shown that the one permanent method of stopping willful waste and plumbing leakage within the premises was to meter each service.

A great deal of underground leakage was discovered and stopped each year that the Water Survey Division was in existence. However, after six years' effort by this division, during which time it had been determined that the only permanent way to stop willful waste and plumbing leakage was to meter, the appropriation for this work was cut off, consequently, the work was stopped early in 1913; but this work had demonstrated that the only solution for the problem of ever-increasing water consumption in Chicago was to meter every service in the city.

From 1913 to 1919 no organization was authorized to carry on the work of making water surveys. However, from time to time, when the district engineering field forces could be spared, many special tests were made and important information was obtained regarding the rate of consumption. In most cases it was found that the major portion of the flow was due to plumbing leakage and willful waste inside the premises.

An example is cited below of the water surveys made in Hegewisch which showed that the domestic daily per capita rate of flow had increased from 120 gallons per day in 1910 to 433 gallons per day in 1920. Owing to the conditions existing it was recommended year after year that this section of the city be metered. This was finally accomplished in the fall of 1920 with the result that the domestic usage dropped from 433 to 75 gallons per day per capita. This demonstrated what meters could do in stopping plumbing leakage and willful waste.

In 1916, the policy of testing for underground leakage and stopping the same in streets which were to be paved was adopted by the Bureau of Engineering. From 1916 to date, over 600 miles of city mains have been tested and the underground leakage eliminated. Approximately 16 per cent of all the water mains in the city of Chicago have been tested. These streets are not chosen by the Engineering Bureau but are taken as the improvements are passed by the Board of Local Improvements, a separate department of the city government, and the mains so tested are scattered throughout the entire city. Of the mains tested, it has been found upon first test that about 66 per cent of the mileage is without underground leakage. If the average amount of leakage per mile throughout the city is assumed to be the same as the average on these pipes, then the underground leakage is approximately five per cent of the water pumped.

The feeder surveys which were made every year showed the engineers where the water was going, but they were unsatisfactory because they required too much estimating, and the results could not be proved. In 1919 it was decided to make a comprehensive survey of the whole city using the square mile, or district as close thereto as could be isolated, as a unit. These square mile surveys were made by the regular Feeder Survey parties of the district engineers' offices and required about four years to complete because the work was done supplementary to the other work of the parties and because of certain seasonal conditions during which it is not desirable to carry on this kind of work. Each square mile was examined to determine the number of people and character of the residential occupation, the amount and character of the industrial occupation, and the probable future development of each. This information is necessary for an intelligent design of future extensions to the water system which requires a thorough knowledge of not only the quantity of water to be required but also the location where the consumption will take place and the time of the peak load requirements.

The amount of water going into each section was determined by methods similar to those used by the Division of Water Surveys which have already been described.

The amount of metered water entering a section was determined from the meter readings obtained from the Water Office, and the curve showing the hourly variation was determined by reading several representative meters three or four times a day during the period of the survey and assuming that the others varied at the same rate. The unmetered water curve was obtained by subtracting the meter from the total flow.

In making these surveys it was found that

nearly all of the industrial water was metered. The construction of a curve for allowable usage was therefore reduced to determining what was a reasonable amount for domestic use, public use, and unavoidable loss in delivery. These quantities vary according to the density of population per mile of pipe, kind of plumbing in buildings, area of parks, season of the year, and other factors. Each square mile was analyzed and the amount for domestic water was found to be the controlling factor except in several square miles which were wholly industrial. The allowable domestic use was determined by allowing liberal quantities for all purposes for which water is used legitimately in a home, and also by measuring actual quantities used in buildings now not metered. The total estimated maximum allowable usage is the amount for the particular time of year and the circumstances under which the survey was made. The difference between the total flow and the estimated allowable use is the estimated leakage and waste.

The per capita rate for the whole city agrees closely with the figures submitted in the "Report on Present Working Conditions and Future Requirements of the Chicago Water System" compiled in 1922. The average allowable daily per capita use for a summer day was established in that report as 146 gallons. The allowable daily per capita use for miscellaneous dates throughout the year is estimated in this report as 136 gallons.

These square mile surveys have been completed so recently that they form an excellent guide to the order in which meters should be installed. It is known just where the maximum waste occurs and hence where the maximum benefit can be obtained as a result of meterization.

## Types of Waterworks Pumping Plants In Service

We had occasion a short time ago to collect information concerning the types of pumping plants used by public waterworks in 344 cities throughout the United States. The largest number used of any one type was electric, there being 198 of these. Next came steam with 111 plants, then gasoline with 19, oil with 10 and finally water power with 6.

Of the 6 waterpower plants, 1 was in Connecticut, 1 in Indiana, 2 in Michigan, 1 in Nebraska and 1 in the state of Washington. Of the 10 oil plants, 1 was in Arizona, 2 in Arkansas, 2 in Iowa, 1 in Kansas, 1 in Kentucky, 1 in Ohio, 1 in Texas and 1 in Wisconsin.

Of the steam plants, 1 was in Arizona, 2 in California, 1 in Connecticut, 2 in Georgia, 12 in Illinois, 12 in Indiana, 4 in Iowa, 2 in Kansas, 3 in Kentucky, 1 in Maryland, 6 in Massachusetts, 12 in Michigan, 2 in Minnesota, 1 in Mississippi, 1 in Missouri, 1 in Montana, 1 in Nebraska, 2 in New Jersey, 7 in New York, 3 in North Carolina, 1 in North Dakota, 10 in Ohio, 1 in Oklahoma, 8 in Pennsylvania, 1 in South Carolina, 1 in South Dakota, 1 in Tennessee, 1 in Virginia and 11 in Wisconsin.

The cities from which reports were received were located in 38 of the states, and in none of these states were there not some cities reporting the use of electricity for pumping their water supply.

## Reducing Concrete Mixer Prices

In a recent letter to the members of the Associated General Contractors of America, J. H. Ellison, president of that organization, said:

"In the two years that have elapsed since the Concrete Mixer Manufacturers organized themselves as a unit of the Affiliated Bureau of the A. G. C., much has been accomplished toward the elimination of unnecessary sizes and models, and the perfecting of those which remain. We have experienced a substantial reduction in prices, and have been able to purchase more efficient machinery than ever before.

"The mixer manufacturers tell us that these benefits have resulted largely from their ability to eliminate waste in manufacture and selling practices, made possible through the concrete mixer standards and the A. G. C. Affiliated Bureau.

"The manufacturers who are co-operating with us represent approximately 90 per cent of the total production of mixers and pavers in the United States.

"We recognize the benefits which have accrued to date in this co-operative effort, and envision the possibilities for the future. It is my sincere hope that every member of the A. G. C. will get behind these manufacturers, support the concrete mixer standards and insist on an A. G. C. name plate on every mixer he purchases."

# Head Losses in Rapid Sand Filters

**Results of tests made at the Cambridge, Mass., plant under operating conditions and conclusions therefrom**

Tests have been made on filters by various investigators both to determine the characteristics of flow during the normal functioning of the filter and also to investigate the behavior of the filter during washing. These tests have usually been made either on experimental units or on new filters containing comparatively clean sand which had not become coated by the accretions which accumulate with longer service. Conditions existing in a plant under actual operating conditions have been studied by Richard G. Tyler, Prof. of Sanitary Engineering, Mass. Institute of Technology; W. A. Danielson, Major, Construction Division, Q. M. C., Washington, D. C.; and Maurice Lebosquet, Jr., assistant engineer with Morris Knowles; and were described by them in a paper before the New England Waterworks Association.

The tests were made at the Cambridge, Mass. filter plant. At this plant each of ten filter units contains 27 inches of sand superimposed on 9½ inches of graded gravel drained by a Wheeler bottom. During the investigation the depth of sand had been reduced to between 24 and 26 inches. When the sand was placed in the filters it had an effective size of 0.31 millimeters, and a uniformity co-efficient of 1.85; but since the filters have been put into use, some of the fine sand has been carried out during washing so that a total of 10 to 15 percent had been so lost and the effective size was increased in the various units to about 0.44 in Nov. 1923 with a uniformity coefficient averaging about 1.43.

In order to find the pressures at various desired depths in the sand or gravel without interfering with the normal operation of the filters, slotted quarter-inch pipes were placed with the slot horizontal and at the desired depth, and these were connected through glass tubing to the mercury columns of a multiple manometer. The tubes and piping were filled with water, a connection being left at the top for connecting a vacuum pump for this purpose. One manometer measured the head acting at the surface of the sand and by adjusting the mercury column so this should read zero, each of the remaining manometers read directly the loss of head in the sand above the gauge tube to which it was connected.

The authors of the paper described at some length the very carefully designed provisions made for securing accuracy and precision in the readings of the manometers. From a study of the data and from observation of the operation of the plant during the tests, augmented by information furnished by Prof. M. C. Whipple and H. C. Chandler, the authors of the paper arrived at certain conclusions which they summarized as follows:

1. Head losses due to the friction in the sand itself are relatively unimportant when compared with those due to clogging or to the floc film on the filter surface. The size of the sand is more important from the standpoint of its effect on the length of run.

2. With proper washing technique, a fairly complete separation and segregation of the sand grains of different sizes can be obtained.

3. With the coarse sands used in filters (0.35-0.45 mm.) this segregation is necessary for the most effective removal of suspended solids by the filter.

4. The effective filtering stratum consists of the floc layer on top of the sand and the fine surface sand which supports it.

5. The coarser sand at depths below 0.5 ft. has only slight value in removing solids that have passed through the finer surface layer. Its principal function is to support the effective filtering stratum and to furnish the intermediate sizes between the sand of that stratum and the gravel below.

6. The small uniformity coefficient usually specified is not so important where the floc carried over onto the filter is of fair size and toughness so that it is retained on the surface. For a given effective size, a larger uniformity coefficient would give a more uniform grading off into the gravel than is at present secured.

7. It would appear to be more logical to specify filter sands by stating the effective size to be obtained in the top layer (say 3 in. depth), after specified washing, and secure thorough grading throughout the vertical section by proper washing technique, as has been done at some plants.

8. A larger effective size is permissible where floc is consistently coarse or where the detention period in the sedimentation basin is relatively short. Where the condition of the water or the plant is such as to peptize the floc, color, etc., a smaller effective size is needed. Thus at St. Louis an effective size of 0.38 mm. was the smallest desirable, while at Cambridge 0.28-0.30 would be nearer the limiting size, at periods of poor flocculation.

9. The runs vary with coarseness of floc, and the coarsest, most rapidly formed floc is not necessarily the best, as length of run may be too short. For best operating conditions, some intermediate condition is required, depending on settling capacity.

10. With coarse floc, removal is by surface-retention, while with fine, the filter functions more as a sedimentation basin with greater removal in the voids.

11. It seems possible that depth of sand might be decreased where a larger uniformity coefficient gives more rapid grading from top sand into gravel sizes.

12. The filter surface breaks through the upper 0.05 ft. or more in numerous fine cracks which increase the effective surface area of the filter. In no case did these cracks reach the gage tube at 0.10 ft. depth.

13. Negative pressure occurs first at about 0.50 ft. depth and extends downward, but eventually upward also as clogging of the surface proceeds, finally extending from the bottom upward to within about 0.20 ft. of the surface. These depths vary with the characteristics of the floc.

14. A greater proportion of positive to negative head in the filter might possibly be advantageous in giving longer runs and might minimize trouble from the filter becoming air-bound. There was, however, no evidence of trouble from this source in the filters tested, and there seemed to be very little air released in the filters. Sudden increases in the positive head as occurred at times when the water depth on the filters increased, appeared to compact the surface of the filter and cause a sudden increase in head loss.

15. With aluminum sulphate floc, a greater per cent. was removed on the surface of the filter than with floc from sodium aluminate, under the conditions operating at the time of the test.

16. The effective size is more useful in comparing filter sands than it is in comparing sands of widely varying characteristics. With similar grains, per cent. of voids, and a comparatively small range in grain size, the effective size gives

nearly as good results as the surface modulus or specific surface, but with dissimiliar sands this is not the case.

Some of these conclusions are restatements of facts that have been presented before by other investigators, and the present investigation but adds additional evidence in their favor. The last statement in this summary, however, warrants further remarks. Dr. Terzaghi recently stated that in his opinion the mechanical analysis of sands or soils was far from all that could be desired as a means of defining the material or predicting its behavior under given conditions. The tests that have been made and are now in progress at the Institute, appear to bear out this statement, and any factor which depends on a sieve analysis for its determination cannot, from the nature of the case, be entirely satisfactory. This applies to the effective size, uniformity coefficient and surface modulus. The latter, however, has the advantages claimed in a former paper*, resulting from the greater ease and accuracy of its determination and from its greater consideration for all of the sand sizes, but this advantage is only relative. The specific surface has the further advantage of including the effect of compactness. As yet no satisfactory method has come to our attention for determining the true specific surface, for the shape of grain should be taken into account, while in these computations they were considered as spheres. In rating the sieves, grains passing each sieve were measured with a microscope along their three principal axes so this variation could have been taken into account. But irregularities of surface are too complex to be determined in this way.

It appears that the important facts to be determined in regard to a sand are the shape of the grains, the total and individual volume of voids in the material in place, and the character of the surface itself. These items are not measured by the sieve analysis though such an analysis is helpful, as above pointed out, in comparing similar materials, as, for example, filter sands. What is needed would appear to be, not so much an increased refinement in the present methods of analysis, but some other method of analyzing the sample so as to measure either directly or indirectly the characteristics concerning which information is desired. Such a test should be capable of measuring some function of the size, shape, and smoothness of the grain and the compactness of the mass as a whole. The specific surface includes all of these, even smoothness being a matter of surface irregularity. A permeability test measures these variables better than other tests now in use, but such a test is much more difficult to make than the sieve analysis and there are more possibilities of error in its performance. Possibly a test to measure the capillary characteristics may be as specific as a test of the latter function, while having the advantage of greater ease and simplicity in its performance, as suggested in a former paper.*

*"A Fineness Modulus for Filter Sands," by Richard G. Tyler. N. E. W. W. A. Journal, Vol. 39, p. 239.

## Ultra-Violet Rays as Test of Water Purity

In a communication to the Académie des Sciences, Messrs. Duclaux and Jeautet have suggested that the transparency of pure water to ultra-violet rays may be used as an index of its potability. They state that chemically pure water for lengths of 10 cm. is transparent to wave lengths as small as 1,900 A., i.e., well down in the ultra-violet. "It is remarkable that all the substances ordinarily found in what is called pure water, that is to say, mineral salts, fail to diminish sensibly this transparency, provided that their concentration does not exceed that usually occurring in springs. On the other hand, substances under suspicion, that water may contain, render it opaque and in general, the more so the more serious or the more recent the contamination which they betray." Ammonia, proteins and albumin show their presence by increased absorption in the ultra-violet. Sewage water, stagnant water and water from house drainage, all show opacity, even after being filtered. Well water from different sources, though transparent and colorless, distinguishes itself from pure water by its absorption. Water from a stream that has passed through a small town is more opaque than a sample taken above the town. Strangely enough, rain water is opaque in the extreme ultra-violet. The cause of this is not known.

## Water

In the pre-Volsteadian days, a southern colonel responding impromptu to a toast on "Water" summed up in an eloquent fashion, the feeling held by some persons who consider water other than as a thirst quencher. Responding, he said:

*Water*—the purest and best of all things that God created.

I want to say to you that I have seen it glisten in tiny tear drops on the sleeping lids of infants.

I have seen it trickle down the blushing cheeks of youth and go in rushing torrents down the wrinkled cheeks of age.

I have seen it in tiny dewdrops like polished diamonds when the morning sun burst in resplendent glory o'er the eastern hills.

I have seen it in the rushing stream rippling over pebbly bottoms, in the river rushing over precipitous falls in its mad rush to join the mighty Father of Waters and I have seen it in the mighty ocean on whose broad bosom float the battle fleets of all nations and the commerce of the world—

But—ladies and gentlemen, I want to say to you now, that as a beverage it's a damn failure.

*From a paper on "Public Health vs. Water" before the Central States Section of the A. W. W. A. by H. E. Moses, Ass't Chief Engineer, Pennsylvania Dept. of Health.*

## Water Main Extensions in Dayton

The latest annual report of the city of Dayton, Ohio, states that during the previous year there had been laid 4,359 feet of 1-inch wrought iron private lines in connection with the water distribution system. These private lines result from scattered houses in territories where the growth is insufficient to warrant main line extensions. Where a district shows 8 per cent return on the cost of construction, a water line is laid free

of cost to the consumer. Where this is impossible, the consumer advances the cost of the main, which is refunded to him when the extension shows a return of 8 percent upon the investment. Where this plan proves impracticable, private lines are permitted and are always installed at the entire expense of the property owner without refund; although, whenever a main line is laid, the services off a private line are connected up with the new line free of charge to the consumer.

## Old Cast Iron Pipes

At a meeting this winter of the Institution of Water Engineers in England, a paper was read describing repairs made to a reservoir which was built in 1824. Certain defects had appeared in the embankment and the outlet of the reservoir and in making the repairs cast-iron pipes laid in 1824 were encountered. Concerning these the author of the paper, John A. Swales said: "The flange joints had been made with a wrought iron flat ring wrapped with several layers of tallowed tape. The wrought iron ring was in excellent condition as, in fact, was the whole joint, including the wrought iron bolts. The cast iron pipe itself was of excellent quality, could be drilled almost with the ease and characteristics of mild steel, showed no material signs of deterioration, and was as sound as on the day when it was put in."

A valve 80 years old was found to have gunmetal faces still in excellent condition except for physical wear, although a valve placed in 1911 had to have its spindle renewed in 1918, this spindle having been made of a special so-called bronze. (This calls to mind troubles encountered by the engineers of the Catskill aqueduct with bronze valve spindles.) This spindle, renewed in 1918, failed again in 1923 because, it was said, the exterior portion of the spindle had undergone dezincification due to exposure to the water. New valves were being substituted with these parts made of copper 89 percent, tin 9 percent, zinc and lead 1 percent, phosphorus, .06 percent and a trace only of iron.

## Garbage Disposal Problem Near Solution?

Under the above heading (including the question mark) the "Toledo City Journal" for January 8th, discussed a question which is of general interest to the citizens of that Ohio city. Among other things it said:

"The solution to the long-standing garbage disposal problem of the city seems to hinge upon securing a location for an incinerator unit, which will not only be agreeable to property owners adjacent to the contemplated site, but also suitably situated from the standpoint of garbage collection.

"In every section of the city, with one possible exception, in which it has been proposed that an incinerator be located there has arisen outcries from the adjacent residents. There seem to be two important objections to the location of an incinerator unit in the several sections.

"First, many people have the conception that from an incinerator there arise noxious odors which permeate the neighborhood. . . . Second, a natural objection follows from residents along the streets which are adjacent to the incinerator unit and which are very much used for hauling the garbage wagons to the destructor.

"An educational campaign to point out the invalidity of these two objections may be necessary before the first incinerator unit can be constructed."

Probably every city which has built or is planning to build garbage disposal plants of any kind has had the same experience and can sympathize with Toledo. If any of them has found a solution which met the specifications of the first paragraph we know the Toledo authorities would like to hear from them—and so would we.

# Dust Laying on City Streets

**Materials and methods employed by ten large cities. Quantities of oil and calcium chloride used and costs per square yard**

A report on methods employed in large cities in preventing or abating the dust on public streets and alleys was prepared November, 1926, by Frederick Rex, Municipal Reference Librarian for the city of Chicago, at the request of one of the aldermen. Through the courtesy of Mr. Rex we have been furnished with the results of his investigation, which was conducted by correspondence with the cities of Baltimore, Boston, Buffalo, Los Angeles, Minneapolis, Newark, New Orleans, New York City, Philadelphia, St. Louis and Washington, D. C. Most of these cities reported the use of oil, and two also used calcium chloride.

Baltimore reported using fuel oil of 28 to 32 Baume gravity. This is applied at the rate of 1-3 to 1-2 gallon per square yard at a cost of from 3 to 5 cents per square yard.

Boston treats approximately 2,750,000 square yards macadam streets with 45 percent and 65 percent asphaltic road oil, the 45 percent being that used under ordinary conditions and the 65 percent on the hill streets. The former is applied without heating and is found to penetrate readily and has sufficient asphaltic content to make an excellent mat when covered with sand. It is applied by pressure distributors furnished by the contractor who supplies the oil, the contract price being, last season, 6.69 cts. a gallon applied. About 35 pounds of sand per gallon of oil is spread by city forces from trucks owned by the sand contractors. The 65 percent oil is heated when applied by pressure distributors and a coarser sand is used and a heavier blanket of it to prevent bleeding.

Of Buffalo's 700 miles of streets, over 500 are

paved and the remainder either exist only on paper or are not built up, so that there is very little complaint regarding dust. On many of the macadam streets a Tarvia B dressing is used by penetration method and covered with a seal coating of stone chips.

Los Angeles uses 81 percent asphaltic oil. Oils containing a lower percentage of asphalt are found to be less desirable.

Minneapolis uses only asphaltic oil made from Mexican crude oil combined with a volatile distilate.

Newark uses asphaltic road oil containing approximately 35 percent asphalt and costing 10.1 cents per gallon applied to the street. Non-asphaltic oil had been used previously but found to give less lasting results than asphaltic oil.

In New Orleans a number of streets have been treated with 70 percent asphalt oil which has proven satisfactory in laying dust but not from the maintenance standpoint, because it prevents the use of a grader and serious defects soon develop which can only be corrected by the use of a scarifier. The city last fall tried using lighter waste automobile or pit oils, but the trial had not progressed far enough to give definite results.

New York City uses crude oil with asphalt base on the unpaved streets, distributed over the surface by sprinkling trucks; the cost in 1926 being 6.7 cents per gallon delivered in tank cars at railroad sidings. For macadam streets tar oils are preferred but are not suitable for earth roads. The tar costs 10.9 cents a gallon delivered in tank cars.

In Philadelphia, macadam paved streets, which are mostly in the outlying section, are given a bituminous treatment about every other year, or in some cases every year. The best grades of tar and asphalt are used for this work. The material is contracted for applied on the street with modern pressure distributors, and is covered with torpedo gravel, slag or stone chips. Contracted for in large quantities of 100,000 gallons or more the price in 1926 averaged 13 cents a gallon, applied anywhere in the city limits. The average cost per square yard of covering with chips, 20 to 25 pounds per square yard applied by city forces, was 7 1-2 cents per square yard. In the case of unimproved streets such as dirt roads, a lighter and cheaper class of oil is applied, about 1-5th of a gallon per square yard. This costs about 8 cents per gallon applied.

St. Louis applied road oil hot at about 250 degrees Fahrenheit. On dusty roads oil is applied after a heavy rain when the surface seems dry but is still moist underneath; then after two or three days oiled again.

Washington, D. C. uses on the better class of macadam roads a light tar or heavy petroleum oil applied at a temperature of about 100 degrees and covered with stone chips or gravel. For unimproved streets a very light petroleum oil with small asphalt content is used which is absorbed quickly and requires no covering.

Granulated calcium chloride is used by Baltimore, Maryland, the road surface being first thoroughly wetted and the chloride then applied at the rate of 1-2 pound to 1 pound per square yard. The cost of this treatment including the preliminary sprinkling is about 3 cents per square yard.

In Boston calcium chloride is used in the late fall and early spring where openings have been made, being applied dry at the rate of about 2 pounds per square yard. It is satisfactory in keeping dust down until such time as permanent repairs can be made.

## Snow Removal From Highways

Snow removal from highways has become a major problem in nearly all the states north of the Ohio River. A report recently issued by the Construction Division of the Bureau of Public Roads based on reports from 36 states, shows an expenditure for the winter of 1925-'26 of $3,757,663 for snow removal, as compared to $1,862,813 in 1924-'25, and $767,159 in 1922-'23. The mileage of roads from which snow was removed increased from 27,096 in 1922-'23, to 62,167 in 1924-'25, and to 93,006 in 1925-'26. The program outlined by these 36 states calls for snow removal work in 1926-'27 on 92,766 miles of state and Federal Aid roads. On January 1, 1926, there were 106,598 miles of roads in these states having gravel or higher type surface.

Cost of snow removal increased from an average of $28.13 per mile in 1922-'23, to $29.39 in 1924-'25, which was a year of comparatively light snowfall in most of the states, and to $40.40 per mile in 1925-'26.

Equipment in use in 1925-'26 as reported by the 36 states, totaled 3,943 trucks, 2,546 truck plows, of which 2,109 were moldboard and 437 "V" type; 1,348 tractors; 704 tractor plows, of which 206 were moldboard plows and 498 "V" plows; 99 rotor tractor plows; and 1,511 graders.

In most of the states, snow removal is accomplished by the state and local units working in co-operation; but in 2 states the counties have heretofore done all the work; in 2 others, including New York, the actual work is done by counties and smaller governmental units. Massachusetts provides the equipments, and the towns remove the snow.

As illustrating the problem of snow removal, Pennsylvania, in the winter of 1925-'26, spent $734,731 on snow removal work over 5,061 miles of road. Of this amount, $552,114 was for snow removal proper, and the remainder for snow fences, cinders on icy hills, hand shoveling and similar work. Michigan spent $314,350, and New York $590,742 ,with 35 of the 57 rural counties reporting work done. New Jersey, with a carefully planned and extensive organization, spent $322,980.

## Increasing Use of Electricity

The very general use of electricity for both domestic and commercial purposes throughout the United States has caused it to be used by some investigators as an index of increased prosperity and industrial activity. It certainly should take its place as one of several indices of

the growth of the country. A compilation of figures by the Division of Power Resources of the Department of the Interior shows that the production of electricity by pubic utility power plants during 1926 is about 11% greater than during 1925. The figures are based on the operation of all power plants producing 10,000 kwh or more per month, and engaged in generating electricity for public use; including central stations, electric railway plants and certain other plants that distribute to the public supply. Reports are received from plants representing over 95% of the total capacity, and the output of the remaining 5% is estimated, and therefore the figures of output and fuel consumption as reported are on a 100% basis for the entire country. These show the total output of electricity for 1926 as about 73,300,000,000 kwh. About 65% of this was derived from fuel and about 35% from water power.

## Prizes for Road Essays

Prizes offered by the American Road Builders Association for essays by members of highway organizations dealing with construction, maintenance or financing of highways, have been awarded, the first prize to F. H. Murdock, construction engineer of Cleveland, Ohio; the second to Harold Tilton, resident engineer of the Mass. State Dept. of Highways; and the third to J. J. Forrer, maintenance engineer of the Virginia State Department of Highways.

## Traffic Street Appurtenances

Among the many results of the general use of autmobiles and the rapid and enormous increase in street traffic resulting therefrom, has been the introduction in most cities of certain structures, notably traffic signals of various kinds and filling stations. At first these were built with view almost solely to their utility, with no thought of their appearance; but during the past few years the latter has been given considerable thought, not only by city officials, but also, in the case of the filling stations, by the private parties or corporations constructing and operating them.

A recent illustration of this is the offering of prizes by the city of Miami, Florida, for designs for street traffic signals and lighting standards and for filling stations. These were to be selected in connection with the construction of Biscayne Boulevard, which cuts through fourteen improved city blocks and required the widening of a narrow street through nineteen other blocks, and has a total length of 3½ miles. It was expected to open it to traffic during January of this year. It consists of a 65-foot roadway with 17½-foot sidewalks and parkways, which are to be planted with royal palms. At the southern end, where it skirts the new Bay Front Park, it widens out to 230 feet; and in Miami Plaza it is 180 feet wide with a central promenade.

A first prize of $1,000 for street lighting signal and lighting standard was awarded S. Grillo, of New York; while a first prize of $750 for a model filling station was awarded to H. Roy Kelley, of Los Angeles. Altogether twenty prizes were awarded in the two competitions, totaling $4,650. The purpose of the competition was to obtain designs of high artistic value for Biscayne Boulevard and also to stimulate general interest in employing better designs for these structures than those now in general use. A few of the prize winning designs are shown herewith.

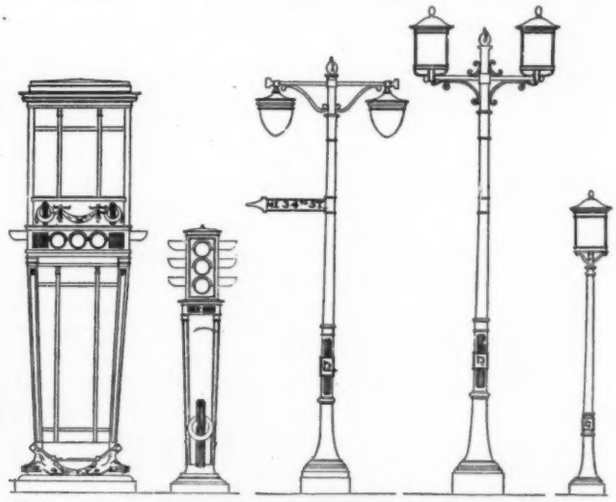
So many excellent designs were received for model filling stations that the Biscayne Boulevard Association believes they will be of general interest throughout the country and expects to publish the min phamphlet form. Some of the prize winning designs are shown in the accompanying illustrations.

## Contracting Course in North Carolina

A course in contracting is to be opened next Fall at North Carolina State College, according to an announcement made by Dean W. C. Riddick, of the Engineering School. The new course is the outgrowth of a request from the North Carolina Branch of the Associated General Contractors of America, represented by H. P. Grier, a former graduate of State College, and who is now a prominent contractor in Statesville.

The course as outlined by Dean Riddick will be very similar to the contracting course now being given at Yale. For the present, the work

FILLING STATION DESIGN BY H. ROY KELLEY. RECEIVED FIRST PRIZE



SOME PRIZE-WINNING DESIGNS FOR TRAFFIC SIGNALS AND LIGHT STANDARDS

will be a division of the department of Civil Engineering, but it is expected that the course will soon grow into a separate department. The work in the new course will be made as practical as possible. Students will be required to do actual construction work before receiving their degrees.

## Grading Road Gravel

A paper describing a simple and reliable method of telling beforehand whether or not a given gravel supply is likely to pack into a hard and uniform surface in a reasonable space of time, was presented before the Canadian Good Roads Association by E. Skarin, president of the Crown Paving and Construction Co., Edmonton, Alta., which, slightly condensed, was as follows:

First—It is important that the gravel be of a hard, durable quality.

Secondly—It must not be too large in size, and

Thirdly—It must be properly graded.

We know that all inert substances, in order to be reasonably stable, must also possess a fair measure of density. The question then whether or not a given gravel deposit will pack into a hard and uniform road surface comes down to this one thing—density.

It then becomes necessary to sample the gravel with proper screens, and besides one must follow some method or formula in order to know when the maximum density is attained. If coarse gravel of say 2 in. is allowed, it is far more important that it is properly graded than if 1 in. were specified. It also follows that it is better for packing purposes to have an excess of fine material in the gravel than an excess of coarse material, provided, however, that the fine excess is not so fine as to approach a loam. Too much fine loam in the gravel will tend to pack easily, but it does not wear so well, and tends to become muddy in wet weather.

A small excess of the coarser ingredient within the size prescribed will take a couple of months longer to pack, but in the end will give a better road surface. It will last longer and give better service in wet weather.

Generally speaking, it is safe to say that if a fine gravel is used of about ¾ in. to 1 in., one need not worry much about density because the range is so small that there is bound to be present in most cases enough fine material to insure satisfactory packing. But, if coarse gravel is used, it becomes all important that it is well graded from coarse to fine in order to give reasonably good results.

Coming back to the formula for density, there are several useful methods one can follow. In the State of Washington an almost straight line curve was used a few years ago. A still better formula is the Fuller's density curve, which is the formula used in Montana for both road gravel and concrete material. The formula is also useful in any grading of aggregate such as asphaltic mixtures, and is the handiest method for checking density in all aggregates.

The formula is: $d=P^aM$, where d is the screen opening expressed in inches, P is the percentage passing a given size screen, and M is the maximum size stone allowed in a given sample of gravel under consideration.

**Values of p for Different Values of d and M**

| Values of d | Values of M | | | | |
|---|---|---|---|---|---|
| | ¾" | 1" | 1½" | 2" | 2½" |
| 1/30 | 21% | 18% | 15% | 13% | 11% |
| ⅛ | 41% | 35% | 29% | 25% | 22% |
| ¼ | 58% | 50% | 41% | 35% | 31% |
| ½ | 82% | 71% | 58% | 50% | 45% |
| ¾ | 100% | 87% | 71% | 61% | 55% |
| 1 | ... | 100% | 82% | 71% | 63% |
| 1½ | ... | ... | 100% | 87% | 78% |
| 2 | ... | ... | ... | 100% | 90% |
| 2½ | ... | ... | ... | ... | 100% |

The advantage of this curve is that it indicates clearly the proper proportion of the varying sizes that should be present in any aggregate where density is essential. The thing then to do with any gravel sample is to pass it through a set of screens and plot the resulting percentages alongside this curve. This will at once indicate whether there is close harmony between the two; and if there is not, it will clearly show what is lacking in the sample. A variation to either side of 15 per cent is usually permitted.

## Current Research Projects of the U. S. Bureau of Public Roads

By H. S. Fairbank*

The following is a condensed statement of the status of the more important research projects of the Bureau of Public Roads current on December 31, 1926.

*Motor Truck Impact Tests*—The impact tests are still one of the most active researches of the bureau. Tests to determine the effect of the thickness of tread rubber on impact reaction have been completed and the data are being analyzed. Looking toward the practical application of impact studies to highway engineering design and motor vehicle regulation, the bureau is engaged in a program of field tests wherein actual pavement surfaces of various degrees of roughness are being compared in connection with the other major variables of tire equipment, load and speed. It is expected that the data obtained will give valuable practical information on the magnitudes of the impact reactions to be expected when known conditions of the four major impact variables obtain.

A study of the instrumentation is being pursued by both theoretical and experimental methods with the idea of knowing definitely the accuracy of the data under the several test conditions.

*Vibrolithic Concrete Tests.*—One-year tests of vibrolithic and normal concrete slabs have been completed. A report will be published shortly in *Public Roads.*

*Other Concrete Tests*—A series of field tests is in progress for the purpose of comparing the several methods of curing concrete pavements.

*Highway Engineer, U. S. Bureau of Public Roads

In addition studies are in progress for the following purposes: To determine the effect of reinforcing on the distribution of transverse cracks; to measure the coefficient of subgrade friction; to make experimental comparison of three methods of concrete pavement curing in cooperation with the State of Maryland; to develop methods of protecting concrete against alkali and salt water with special reference to the use of water-gas tar; to investigate the water-cement-ratio method of proportioning concrete, in cooperation with the New Jersey State highway department; to make fatigue tests of mortar and concrete and tests of the expansion and contraction of concrete subjected to various moisture and temperature conditions, in cooperation with Purdue University; to study the relation between the strength of Portland cement and the strength of the concrete in which it is used, in cooperation with the State highway laboratories; and an elaborate series of tests on the effect of the type and quality of coarse aggregate on the resistance of concrete subjected to repeated frost action.

*Bridge Tests.*—Tests of two experimental bridge slabs constructed for the purpose of determining the value of the floor design of the Philadelphia-Camden bridge have been completed.

*Stability of Bituminous Paving Mixtures*—In cooperation with the American Association of State Highway Officials, a series of tests is under way to determine the relative stability of compressed cylindrical specimens of bituminous mixtures at 140 degrees F., 77 degrees F., and 39 degrees F.

In addition to this an extensive survey of roads in the far western States is being conducted for the purpose of developing an intermediate-cost bituminous surface suitable for that section. The South Carolina State Highway Department is cooperating also in a study of the various bituminous surface treatments for earth roads.

*Subgrade Investigations*—The most active investigation is that which has for its purpose a logical classification of soils with regard to their physical properties. The investigation aims at the development of correlated subgrade information with respect to the soil types shown on the maps of the U. S. Bureau of Soils. This will make these valuable maps of still greater usefulness to the highway engineer.

The investigation includes laboratory studies in cooperation with the Massachusetts Institute of technology and field observations of the relationship between soil types and road surface conditions.

*Highway Transport Surveys*—Traffic surveys similar to those already published are completed in Pennsylvania and Ohio, and reports, now in preparation, will be published in a short time. Other surveys have been completed in New Hampshire and Vermont.

The following researches and tests are also in progress: investigations to develop and standardize certain tests for concrete aggregates; investigations to develop and standardize the direct tensile test for concrete and the stability test for bituminous mixtures; studies in cooperation with the University of North Carolina, to determine the strength of various kinds of culvert pipe under actual fills; field studies of landslides in relation to highway location, construction, and maintenance, in Ohio and West Virginia; and the effect of highway improvement on rural land values.

Probably one of the most important investigations is that aimed to discover the causes of low efficiency in road-construction methods with special reference to grading operations and the mixing and placing of concrete in pavements.

## Footpaths on Highways

An English engineer, J. B. Wikeley, in a paper in "The Surveyor" (of London) for December 10th makes a plea for footpaths on the main roads which is equally applicable to this country. He claims that footpaths would be to the advantage not only of the pedestrians but also of the vehicular users of the highways. "If a footpath at least as attractive and as comfortable as the roadway is not formed," says he, "the pedestrian will use the road, and although his desire for relative safety will keep him off the crown of the road, his love of comfort will not allow him to walk in the gutter or on the heavily cambered haunches. Assuming two persons walking together on the side of the road and allowing two feet width for each person and two feet between the curb and the near pedestrian, we have six feet of roadway lost to vehicular traffic. If these circumstances obtain on each side of the road a width of twelve feet is taken up which, in a thirty-foot road, is 40 percent of the total." This leaves only two nine-foot strips for vehicular traffic where three ten-foot strips were really provided. Equally as good service would be provided, he thinks, by a roadway 20 feet wide and one 6-foot path, and at much less cost.

He states that in some cases in England on rural roads an ash path is provided along the side of the road, but is not used, as the tar or asphaltic surface of the roadway proves more attractive. He, therefore, recommends the use of tar macadam consisting of two inches of tarred stone or slag laid on ashes and with ½-inch top, giving a foot walk which, while relatively cheap (about 4 shillings a yard), meets the requirements. In most cases a width of 6 feet on one side only will suffice and should be laid as far away from the roadway as possible in order that walkers will not be annoyed by the proximity of the traffic. On district roads (usually macadam) where there is less traffic he suggests ashes well consolidated and covered with a layer of gravel. A somewhat better form of construction at little increase in cost consists of a bed of 3 inches of ashes covered with 1 inch of screened gravel well consolidated and then sprayed with tar and covered with ¾ of an inch of chips and the whole then rolled. This costs in England not more than 2 shillings per square yard.

# Researches on Bituminous Paving Mixtures*

**Two pieces of apparatus that are being developed by the Bureau of Public Roads, one to determine the comparative resistance to displacement of bituminous mixtures; the other, a mechanical device for compacting fine aggregate mixtures in tests for voids.**

Reported by W. J. Emmons†

During the past year research on bituminous mixtures has been vigorously prosecuted by a number of organizations. Although attention at present is focused principally upon the development of a test which will define the resistance to displacement of any mixture when subjected to conditions of service, the basic motive behind all such research is the formulation of a rational theory of design or the substantiation of an existing theory.

At the Bureau of Public Roads two pieces of apparatus are in process of development which it is hoped will assist in the solution of the problem. Neither apparatus is perfected, but it is felt that a description of the work being done will prove of interest at this time.

### DISPLACEMENT DETERMINATION

A machine which attempts to duplicate to a certain degree the action of traffic on a pavement surface has been designed for the purpose of determining the comparative strength or resistance to displacement of bituminous mixtures. Figure 1, shows in diagrammatic form the arrangement of this machine. The essential feature is a series of 11 steel cylinders or rolls, 4 inches in diameter by 3 inches long, mounted between and near the peripheries of two confining steel disks, which in turn are rotated by a motor. Beneath the rolls is a water-tight bath or tank in which is placed the specimen to be tested. At the beginning of the test the rolls are lowered gently to the surface of the specimen and the motor started. Rotation of the rolls takes place as they pass over the specimen, tending to deform it longitudinally. A certain amount of impact is also imposed as each roll leaves the specimen and the following one comes in contact with it. A small metal plate held lightly against the end of the specimen and connected with an Ames dial by a brass rod constitutes the device for measuring deformation.

The specimens are prepared by hand mixing and are compacted in a rectangular, collapsible steel mold by means of an electric hammer fitted with a square tamping end. Specimens 8 by 6 by 2¼ inches in size have been used in most of the work thus far, although at present the behavior of a smaller size specimen, 8 by 4 by 2¼ inches, is being investigated. In each case the face of greater area is exposed to the action of the machine.

As might be expected, widely different test values may be obtained by varying the conditions of the test. An arrangement of the machine and of the specimen was sought which would give a wide range in strength values between weak and strong mixtures. The weight imposed by the rolls is susceptible to adjustment by means of counterweights to a maximum of 450 pounds, and the speed of rotation may be varied from 4 to 10 revolutions per minute. The degree of support provided for the specimen under test greatly affects the results; and it has been found best to confine it in a frame at the rear and the two sides. The end toward which the movement takes place has at times been left entirely unsupported, but it is probably better to insure against slipping of the entire specimen by providing small plates partially closing the fourth side of the rectangle.

For the purpose of bringing out the effect of these many variables, rather than of deriving definite information regarding mixtures, many short series of tests have been run. The typical series shown in Figure 2 were made on 8 by 6 by 2¼ inch specimens, with a machine speed of seven revolutions per minute, a load of 250 pounds, and a testing temperature of 60° C. The same aggregate was used in all the specimens represented by each group of curves, the bitumen being varied as indicated.

Several indications of the test are evident from the chart (fig. 2). The test appears to differentiate clearly between mixtures varying in bitumen and dust content. It is very sensitive to slight variations in the density of well-compacted specimens. It is also apparent that a series rather than a single test is required to define the characteristics of any mixture. The failure of certain specimens to check with the average of their respective groups may be due to lack of uni-

*Paper before the Fifth Asphalt Paving Conference.
†Highway research specialist, U S. Bureau of Public Roads.

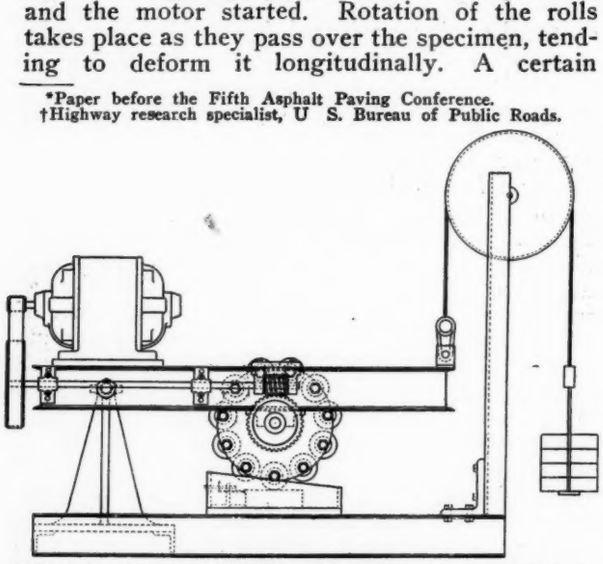


FIG. 1—ROLLER MACHINE FOR TESTING BITUMINOUS PAVEMENT SPECIMENS.

formity in their densities or to certain other conditions of testing or molding which are as yet not clearly understood.

Considerable thought has been given to the method of interpreting curves of this nature. It is evident that data in this form are of little practical value without a knowledge of the degree of density to which mixtures may be compressed in service. Comparatively little information is available, but a study is being attempted which it is hoped will shed light on the matter. As a step in that direction, dry-aggregate voids tests are being made on the aggregate extracted from samples of pavements of different ages, and the results of these tests are compared with the computed voids of the aggregate as it exists in the original sample. Insufficient work has been done to warrant definite conclusions, but from the tests which have been made it is indicated that the voids existing in an aggregate may afford a measure of the compressibility of the aggregate when combined with bitumen.

As a tentative method of comparison between mixtures, the curves of Figure 2 are extended to the point of maximum possible compression indicated by the voids tests upon the aggregates. Unfortunately, these series do not include enough tests to define the slope of some of these curves as well as might be desired, but it seems that with percentages of bitumen which are less than sufficient to fill the voids in the aggregate, a compression can be attained which is, as a rule, within 1 per cent of the computed maximum possible density.

### VOID DETERMINATOR

Another device developed by the Bureau of Public Roads is a mechanical means for compacting fine-aggregate mixtures in the test for voids. This apparatus is shown in Figure 3. A steel disk, 11 inches in diameter and 11-16 inch thick, carries the aggregate containers and is vibrated

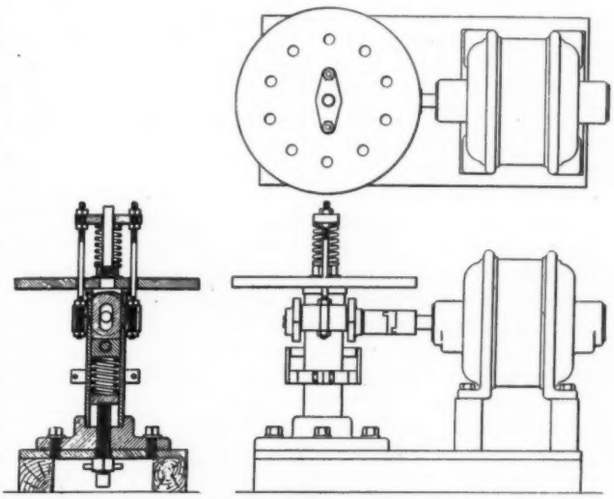


FIG. 3—APPARATUS USED IN DETERMINATION OF VOIDS.

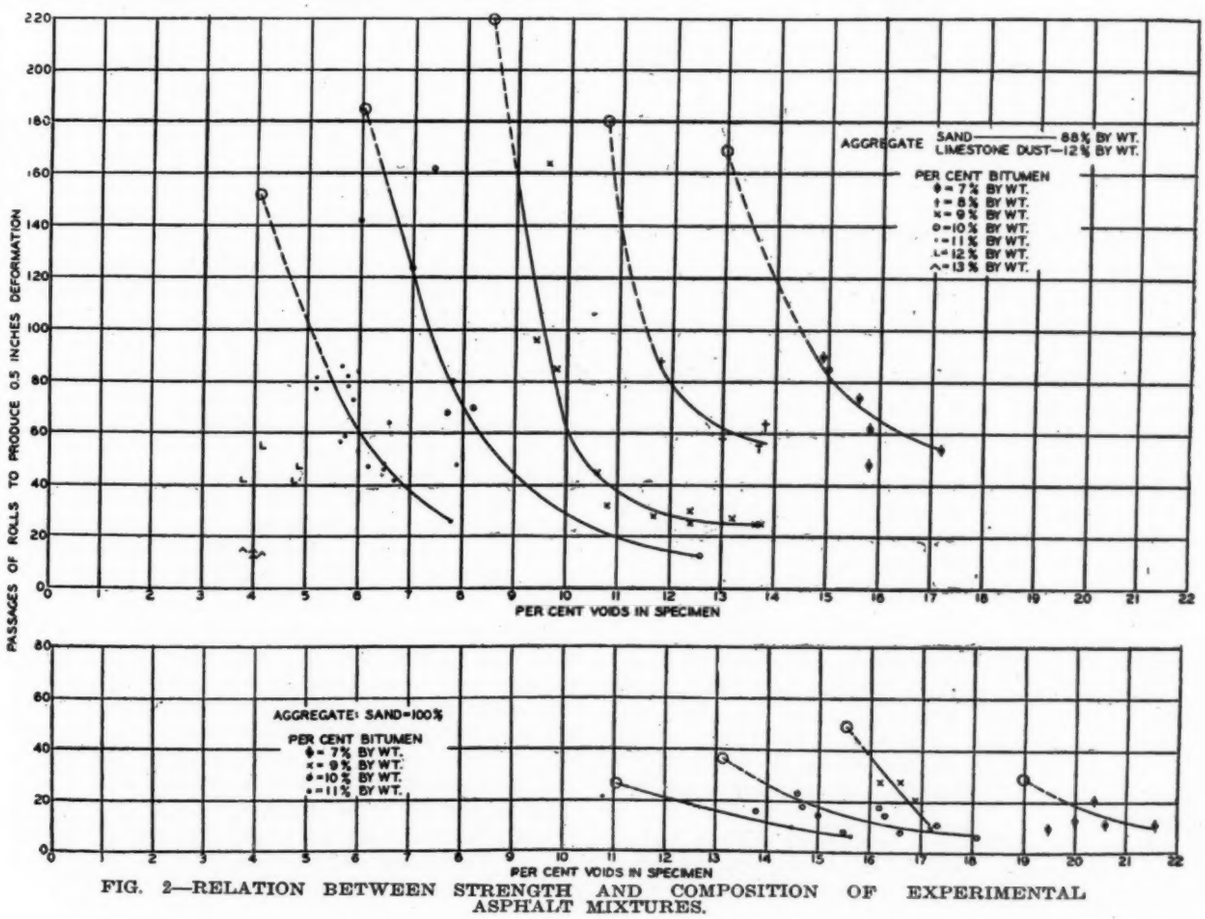

AGGREGATE SAND——— 88% BY WT.
LIMESTONE DUST—12% BY WT.
PER CENT BITUMEN
◆ = 7% BY WT.
† = 8% BY WT.
× = 9% BY WT.
○ = 10% BY WT.
• = 11% BY WT.
L = 12% BY WT.
△ = 13% BY WT.
PASSAGES OF ROLLS TO PRODUCE 0.5 INCHES DEFORMATION
PER CENT VOIDS IN SPECIMEN
AGGREGATE: SAND=100%
PER CENT BITUMEN
◆ = 7% BY WT.
× = 9% BY WT.
○ = 10% BY WT.
• = 11% BY WT.
PER CENT VOIDS IN SPECIMEN

FIG. 2—RELATION BETWEEN STRENGTH AND COMPOSITION OF EXPERIMENTAL ASPHALT MIXTURES.

rapidly between the lower and upper springs. Two cams driven by the motor are attached to the shaft, passing through the central column of the machine, alternately compressing and releasing the lower spring at the rate of about 1,500 times per minute. The throw of the disk is adjustable up to a maximum of 0.04 inch.

Figure 4 illustrates the types of containers which have been used to hold the aggregate being tested. The disk of the vibrator is perforated with ten ⅝-inch holes equally spaced on a circle concentric with its circumference. The bases of the containers are equipped with threaded rods by means of which they are bolted to the machine. Either cylindrical or conical containers may be used; and each container is fitted with a removable sleeve which may be attached to it by spring clips or by threads. At the beginning of the voids test, the sleeve is attached, slightly more aggregate than is necessary to fill the calibrated container is introduced, a rubber-shod cylindrical metal plunger is placed over the aggregate, and the whole apparatus is bolted to the vibrator. A 20-minute period of vibration has thus far been employed although it is likely that a somewhat shorter time may be sufficient to produce thorough compaction.

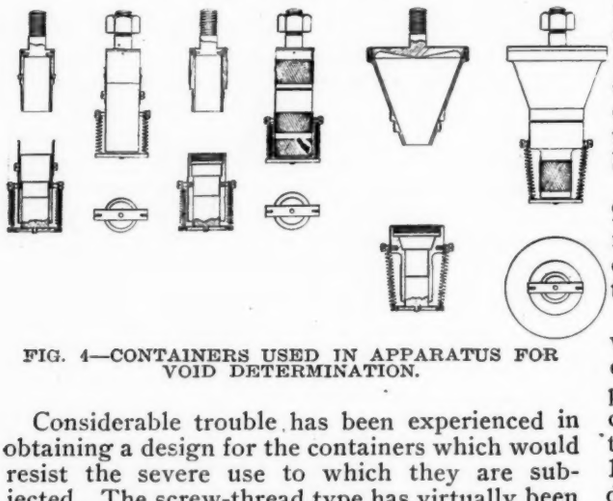


FIG. 4—CONTAINERS USED IN APPARATUS FOR VOID DETERMINATION.

Considerable trouble has been experienced in obtaining a design for the containers which would resist the severe use to which they are subjected. The screw-thread type has virtually been discarded since it was found all but impossible to prevent dust from seeping into and ruining the threads of the containers. The spring-clip type seems to be more durable, but as the holes in the clips wear larger it has been found necessary to take up the looseness which develops by wrapping and compressing a rubber band between the shoulder of the container and the sleeve.

Cylinders should be made by boring a solid steel rod in order to insure the greatest rigidity. Certain of the cylinders originally made have lately given erratic results and this has been traced to a very slight looseness which developed between the bases and the walls which, in this case, were turned out separately and assembled.

Most of the work has been done with cylinders 1 inch in diameter and of approximately 26 cubic centimeter capacity. Determinations by the method of hand tamping have been made concurrently with the machine test, using containers of identical construction for both purposes. Voids have also been calculated as they exist in 2-inch diameter cylindrical specimens of sheet asphalt mixtures compressed by the method devised by Hubbard and Field. The aggregates of these specimens were combined with percentages of bitumen from 7 to 14 per cent.

On the basis of the work done thus far it is believed that in the very near future the vibration method may be developed to give at least as complete compaction as can be obtained by either the more laborious hand method or by the method of direct compression under a predetermined load.

## Street Lighting in Columbus

A few years ago Columbus, Ohio, installed on its streets a number of sample installations of street lights of different designs and residents were requested to indicate by ballot their preferences in regard to the different classes of lighting. The city is now taking the initial step toward adopting a uniform lighting sytem. The main business district of High street (the main thoroughfare of the city) is to be equipped with intensive whiteway units, the secondary business district of the street with less intense illumination, and still another type of the same general design has been adopted for the residential part of the street beyond the business section. More than 500 lighting units of these four types are to be installed along the street.

The main business section will be lighted with 96 twin units, with blue-tint medium alabaster ripple globes and canopies. The lamps will be of 1500 candle-power each, with light centers twenty feet above the ground.

In the secondary business section 166 units will be used, these being equipped with 1500 candle-power lamps at a height of 16 feet and provided with medium alabaster ripple globes and canopies. Between the secondary business and the residential section there will be 18 units with 1000 candle-power lamps to prevent too great a decrease in intensity of illumination such as would prevail if 600 candle-power lamps were placed next to 1500 candle-power units. Except for the lamps, these units will be similar to the 166 units of the secondary business section.

In the residential section, 143 units will be equipped with 600 candle-power lamps and will have light alabaster ripple globes and canopies with asymmetric dome refractors, with lamp centers thirteen feet above the ground.

Each single-light standard will be equipped with a disconnecting pothead type of IL transformer, and each twin-light standard will have two such transformers in the base, one for each lamp. There will also be seventeen subway-type RO transformers, six subway-type contactors, and two automatic pole-type contactors.

All of the electrical equipment will be supplied by the General Electric Company, and the poles, except where the old posts are being remodeled, by the Union Metal Manufacturing Company.

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## Cost Keeping on Street Cleaning Work

"It is essential that the street cleaning industry develop rapidly through interchange of ideas, improved equipment and careful management." To this opinion of Mr. Thompson, expressed in the leading article in this issue, we fully subscribe. Also, unfortunately, we must agree that "as yet no standard uniform system of cost keeping has been established which will enable various cities to interchange statistical data and costs of operation."

As a matter of fact, too few cities have any method of cost keeping for this branch of work that can qualify as a "system." We recognize the difficulties, especially in designating the work accomplished. The area covered is not a sufficient unit for this purpose, for one city may have much more dirt accumulation than another to remove, and one may keep its streets immaculate while in another they are never even reasonably clean; and many local conditions affect the problem. But some standard uniform system will ultimately be worked out, we feel sure; and the sooner it is, the better it will be for both taxpayers and municipal officials who are really interested in this branch of work.

Improved equipment is already available and general adoption of it will encourage inventors to make still further improvements. Progress towards standardization of equipment, by elimination of the uneconomical and ineffective, will also help toward evolving a uniform system of accounting, as well as improving the quality of work done, by substituting more or less uniform and untiring mechanical action for the hand labor which is too often unreliable in quality and the results of which vary greatly between different cities.

These two points—standard records and wise selection of machinery—will be given intelligent and painstaking study by all street cleaning officials who are earnestly endeavoring to promote the efficiency and economy of this branch of municipal service.

## Metering vs. Plumbing Inspection

Opponents to metering of water services are still too common among non-engineering citizens, perhaps the most common reasons therefor being an impression that metering is a scheme of meter manufacturers conniving with city officials to put through a mutually profitable deal at the expense of the taxpayers, and that it will increase the cost of water to the consumers. The answers to these objections seem to be very plain to engineers and water superintendents but somehow fail to convince others. Apparently arguments which are to be successful with the latter must be short and very plain, and citation of actual facts rather than conclusions based on theories, however sound.

Such could be found in abundance if cities which have changed from unmetered to metered condition would but determine and record the essential facts before, during, and after the transition period. Chicago will undoubtedly have

valuable data of this kind if the plumbers' union ever permits the installation of meters at the rapid rate desired. Some of the conditions before metering are described in a report which is abstracted in this issue, and of special interest are comparisons of results of metering with those of house-to-house inspection.

## Assessing for Paving by the Front Foot

In the issue of Public Works for August 1926, we published an editorial discussing the matter of assessing for public improvements, in which we maintained that only occasionally was the benefit accruing from the paving of a street proportional to the frontage of the property on that street.

The United States Court of Appeals, District of Columbia, has recently reversed the Supreme Court of that District, the case being one in which property owners had protested against being assessed for the repaving of Rhode Island Avenue on the basis of the front foot. The Court of Appeals in its decision holds that under certain conditions the front foot method of assessment would be valid, but in taking a more general view of the question delivers the following opinion:

The front-foot method of assessment for street improvement under a general statute is condemned especially on the theory that it taxes the individual property fronting on the improvement for all or a fixed portion of the expense, to the exemption of all other property in the municipality.

It is not a local improvement beneficial chiefly to the immediate property affected; but a public improvement, the expense of which should be borne by all the property of the community on an equal proportionate basis. To thus tax all or an unequal portion of the burden of the expense of a general public improvement against the property of a single person or a group of persons, to the exemption of the public generally, falls within the constitutional inhibition forbidding the taking of private property for a public use without just compensation.

Cooley, in his work on Taxation, 3rd. Ed., 1224, condemning the frontage rule when applied to a public street improvement, said: "It considers each lot by itself, compelling each to bear the burden of the improvement in front of it, without reference to any contribution to be made to the improvement of any other property, and it is consequently without any apportionment. From accidental circumstances, the major part of the cost of an important public work may be expended in front of a single lot; those circumstances not at all contributing to make the improvement more valuable to the lot thus especially burdened, perhaps even having the opposite consequence. But whatever might be the result in particular cases, the fatal vice in the system is that it provides for no taxing districts whatever. It is as arbitrary in principle, and would sometimes be as unequal in operation, as a regulation that the town from which a state officer chanced to be chosen should pay his salary, or that the locality in which the standing army, or any portion of it, should be stationed for the time being should be charged with its support. If one is legitimate taxation the other would be."

This opinion seems to sustain our own personal one as expressed in the editorial referred to, in that it holds that the paving of an important avenue "is not a local improvement beneficial chiefly to the immediate property affected; but a public improvement, the expense of which should be borne by all the property of the community on an equal proportionate basis."

## The Municipal Engineer

The following was written by an English "town surveyor" (municipal engineer), concerning the status of that profession in England, but it applies so aptly to the United States as well that it seems worth while to quote it entire. The writer is Major T. Salkield, in "The Surveyor."

At a meeting of the Institution of Municipal and County Engineers held in Hertford on December 4th (at which the mayor of the borough presided), Capt. H. F. Wilkinson, the surveyor of Tottenham, in the course of his speech, made the following remark:

"Engineers are very much misunderstood by the public and members of corporations; they are regarded as men who want to spend money, but their object is to spend public money wisely for the general good of the municipaities they serve."

These words deserve to be given the widest possible publicity. It is very difficult indeed, on first acquaintance with the subject, to understand why the engineer to a local authority should not be more generally esteemed. He spends the best years of a very active life in the public service endeavoring to meet the ever-increasing demands upon his capacity and time. But this is no new attitude of mind on the part of the public. The surveyor has always been more or less a misunderstood official, and in the old days was very often maligned. The municipal engineering profession (the town surveyors) numbers in its ranks men of the highest capacity, and all are worthy of the honorable and responsible positions they hold.

### NO EXCUSE FOR FAILURE

In every place (urban and rural) this public servant is daily engaged upon works of construction, and in the maintenance of those undertakings upon which the wellbeing of the community depends. It would seem to be the fact that just as it is possible to miss the wood for the trees, so the citizens fail to realise all that is done for them, for the simple reason that it is done without ostentation or failure. As failure or breakdown in either the administration or the running of the public utility services so rarely occurs, the personal factor—the director—is overlooked or forgotten.

Every day the public amenities are enjoyed, and the repetition of these privileges (which occur with the regularity of the rising and setting of the sun) leads to the taking of everything for granted. The medical man makes good the break-downs which occur in the human machine, therefore when his services are requisitioned a crisis has arisen. Doctors are not paid to maintain the normal working of the human machine. Restoration to health is announced as a triumph of professional skill. The municipal engineer has so to design his undertakings that failure must not happen. He is not judged by the continuous success of his operations, but by any single failure which may occur. In the absence of failures, therefore, the public is unable to appreciate the unfailing activities of this executive officer.

HIS MANY DUTIES.

One sometimes wonders how far the public is cognizant of the many and varied duties of the town surveyor. They are so manifold that it is not proposed to attempt a tabulation of even the more important ones. His lot, like that of another worthy, may not, at times, be a "happy one," but this is a Gilbertian phrase and must not be accepted at its literary value.

The town surveyor enjoys the great charm of variety in his work, and it is this which enables him to carry on and to keep smiling. The unhappy holder of such a position is likely enough to be inefficient, too hard-worked, too thin-skinned, or (it has been known to happen) the scapegoat for the incapacity of others. In every walk of life snags are encountered. The public official who is the central figure of this article, is, for the very reason that he is a public official, liable to be misunderstood and subject to attack by those who resent legal interference. Others—the mean and petty—like to score, or think they do, at the expense of the man who is not always in a position to defend his actions by explanatory statements. He (the town surveyor) sees the end from the beginning, but the other is often unable or unwilling to see anything at all. Duty well done is its own reward, and in the doing of it the greatest pleasure is derived.

## The Trend of Prices

One of our members who attended the state highway letting held by the State of Indiana at Indianapolis on December 21st, was thoughtful enough to write us a letter commenting upon the price tendency as shown by the bids submitted.

He says: "Out of a total of fifty-six bids filed, forty-six of them were over the engineer's estimate. As compared with the first letting there a year ago, the results are particularly pleasing, as at that time there were but very few bids, if any, over the engineer's estimate, and in most cases the low bidder was anywhere from $25,000 to $50,000 below the estimate."

In his remarks as to the possible reasons for the changed attitude he states "that by reason of the educational nature of the program carried out in your recent annual meeting and the sad experience of contractors during the past year has caused them to be more conservative in their bids and to include therein a larger portion of the costs than they have done heretofore."

From this it would appear that contractors are beginning to realize that if they are to remain in the business and enjoy any degree of success they must be guided by sound cost information and intelligent estimating and not be influenced by the estimated cost of a given job as may be placed upon it by the engineer. It has been quite some time since we have encountered such a tendency toward better prices and to us it is an indication that contractors are beginning to recognize the fact that they must include all items of cost if they are to break even on highway work.

Now that the movement has been started upward it should be carried forward until the prices on work of this nature reach a fair level. Most certainly they have been very far from that during the past few years.

*From "Public Construction News," official publication of the Illinois Ass'n of Highway and Municipal Contractors.*

## Starting Kick of Motor Vehicles

When a vehicle standing at rest starts into motion there is a tendency for the action of the engine on the drive wheel to result in a lifting of the front wheels from contact with the road. A result of this would be an additional pressure by the rear wheels, which would thus carry a larger proportion of the total load. This may be called the starting kick of the vehicle. It applies of course, only to motor vehicles, and not to horse drawn ones.

It is believed that little attention has been paid to this in the past, but Prof. C. J. Tilden, chairman of the Department of Engineering Mechanics of Yale University, suggested making a measurement of this kick and an investigation of the same was made by Thomas K. A. Hendrick of the Highway Research Board of the National Research Council. Experiments have been made on a bicycle, Buick cars, motor trucks of 5 to 13 ton road weight, and taxi cabs. Measurements were made by placing the rear wheels on a platform scales and noting the increase in weight when the engine started. In each case except that of the Buick, the vehicle was started as one would normally start getting into a car on the highway and driving off. In the case of the Buick car, the gasoline was controlled by the throttle, which was opened to the position necessary for a speed of 35 miles per hour on a level road.

Mr. Hendrick reports: "As a result of the tests, it is believed that it can be stated that the downward kick of the rear wheels of the vehicles, in starting from rest, varies according to the type and classification of the vehicle from 4 to 23 per cent of the load on the rear axle; and from 2 to 11.8 percent of the total load.

"For light passenger vehicles with about 1700 pounds on the rear axle and 3200 pounds total weight, the average downward kick is about 6.4 percent of the load on the rear axle or about 3.4 percent of the total load.

"For trucks with a total weight of 22,000 pounds, 13,000 pounds on the rear axle, the downward kick is about 5.3 percent of the load on the rear axle or 3.2 percent of the total load. For taxicabs with a total weight of 3,500 pounds and a weight on the rear axle amounting to 1900 pounds, the downward kick is 18.2 percent or about 9.1 of the total load. In some cases, depending upon the load and the body characteristics of the vehicle and the idiosyncrasies of the driver, the downward kick of the rear wheels of some passenger cars may easily be ¼ of a ton and for heavy trucks may easily be ½ a ton."

Aside from a slight momentum which may be acquired by the bringing of the greater part of the load on the rear springs, the total downward pressure of the vehicle is not, of course, in-

creased but the load upon the front wheels is relieved by an amount equal to the increase upon the rear wheels. It would not appear, therefore, that this was a very important matter except under certain conditions, such as the rear wheels resting on a manhole cover or a local weak spot in the road.

# Joint Outlet Sewer in New Jersey

## A Notable Example of Municipal Co-operation

By Edward S. Rankin*

An excellent example of co-operation between municipalities in the construction of public works is shown in the consummation of a joint contract between eleven municipalities in Essex and Union counties, New Jersey, for the financing and construction of the joint outlet Sanitary sewer which, when completed, will serve fourteen municipalities, in whole or in part. The municipalities financing the project are the cities of Newark, East Orange and Summit; the towns of West Orange and Irvington; the townships of Millburn, Maplewood, Hillside and Union; the village of South Orange, and the borough of Roselle Park. The project will serve about one-sixth of the city of Newark, one-sixth of the city of East Orange, one-eighth of the city of Elizabeth, one-fifth of the city of Orange, a small portion of the city of Linden, and practically the entire area of the rest of the municipalities mentioned.

Any one who has attempted to negotiate a project requiring the consent of even two municipalities knows the difficulties which arise in persuading the authorities that their particular municipality is receiving its full share of the expected benefits and not paying more than its just share of the cost; but when it comes to convincing the governing bodies of eleven municipalities on these points, some idea of what was involved may be realized, as there is no law by which any of the municipalities could be compelled to enter into the joint agreement.

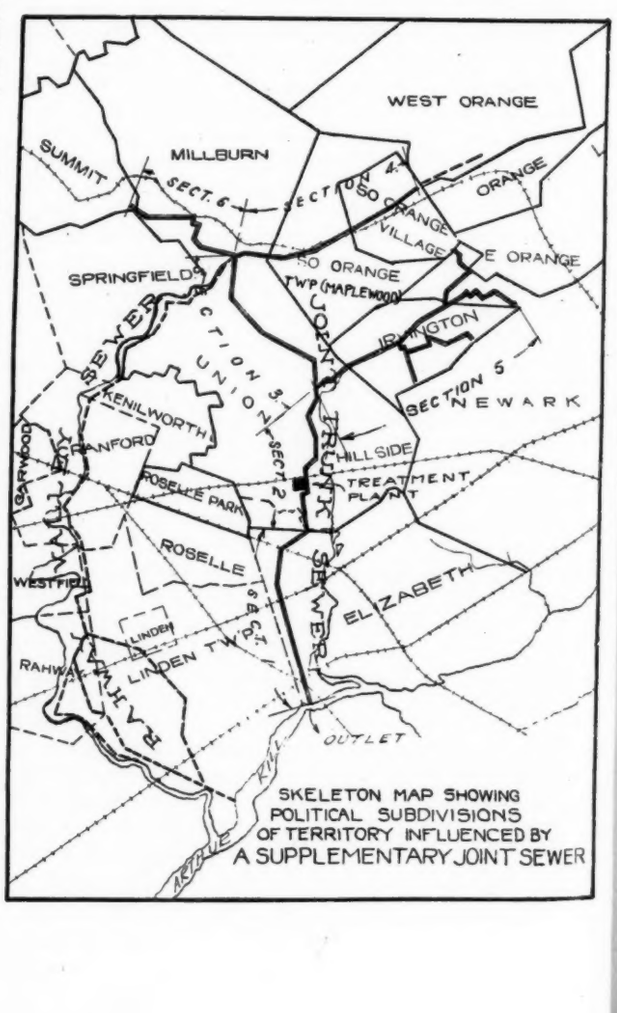
The association is entirely voluntary and is known as the "Joint Meeting," and the capacity which each municipality will own in the sewer was recommended by the engineer, but, to be binding, the capacity alloted and the consequent proportionate cost had to be accepted by each individual municipality. The fact that all have agreed on the capacity assigned and, consequently, the proportion of the cost to be paid by each, speaks well for the justice of the basis on which the cost will be divided.

The sewer is divided into six sections: All of the municipalities will use Section 1, which is the outlet section; ten will use Section 2; six, Section 3; four, Section 4; five, Section 5, and three, Section 6. Each municipality will pay towards the cost of each Section in direct proportion to the capacity of such section used by it.

Other municipalities which will use the sewer but are not involved in the financing of same, will be given this privilege under specific contract agreements.

This project is an outgrowth of the joint sewer constructed in 1902 by six of the municipalities interested in the present work upon the same voluntary scheme of co-operation as covered by the new contract recently executed, which was devised and recommended by Alexander Potter, consulting engineer. It was built under the direction and supervision of Mr. Potter, who has ever since been connected as chief engineer with the maintenance of the enterprise. The rate of growth in population has been phenomenal in most of the municipalities served by this sewer, so that the existing sewer has become wholly inadequate and overflows of crude sewage for weeks at a time are common. This crude sewage pollutes the Elizabeth and Rahway rivers, both of which are used as water supplies below the polluting points, for the city of Elizabeth and the city of Rahway respectively.

It is a number of years since it became evident that speedy action must be taken looking to the enlargement of the joint trunk sewer. When it became known that the plans were being prepared, the five other municipalities named above, two of which were entirely without sewers and the others with inadequate sewerage facilities, asked and received permission to




*Engineer of Sewers, Newark, N. J.

join in the enterprise. Over three years have elapsed since the engineer's preliminary report was presented, and during this time many questions, both engineering and legal, have been raised and met. At times an amicable agreement seemed almost hopeless, but all difficulties have at last been overcome and the rough spots ironed out. A joint municipal contract has been signed and an organization for carrying out the work effected.

The brunt of the work in securing the co-operation of these municipalities fell upon the shoulders of the engineer, and to him much of the credit is due.

It is expected that actual construction will begin within a few months, and it is worthy of note, as indicative of the harmony which now exists, that at the organization meeting the six officers were elected by unanimous vote.

A disposal plant will be erected consisting of mechanically-operated screens, hydro separators and single-story sedimentation tanks, from which the sludge will be continuously removed and transported by barges to sea. Chlorination will be used when required by the State Department of Health. The effluent will be discharged into Arthur Kill.

The State Department of Health requires that a sewage purification plant be constructed coincident with the new sewer, but as the law provides that a sewage disposal plant cannot be constructed without the consent of the municipality in which it is to be located, construction has been delayed until such consent has been secured. The township of Union by ordinance has just given its consent to the construction of this sewage disposal works, so that there should be little delay in proceeding with the construction of this very much needed enterprise.

The supplementary joint trunk sewer will be, in all, some 20 miles in length, ranging in size from 12 to 81 inches in diameter. The area to be served is about 28,000 acres, and the capacity of the sewer at the outlet is 100 million gallons daily.

The executive body in direct charge of the work consists of one member from each of the governing bodies of the eleven municipalities financing the proposition. Simeon H. Rollinson, mayor of the town of West Orange, is chairman; Alexander Potter is the designing and constructing engineer in charge of the project; and Edward S. Rankin, engineer of sewers of Newark, is secretary of the joint commission.

# Water Waste Investigation In Syracuse

**Three years of operation of water waste party of water bureau. Description in detail of how waste investigation is carried on. Results obtained by the investigation.**

By E. P. Stewart*

The value of water waste investigations was learned by the city of Syracuse in 1915-16 and 1919-21 when surveys of the distribution system of the Bureau of Water were made by two different firms of engineers who specialize in this work. It was not until 1923, however, that a systematic survey was inaugurated by the Water Bureau operating with its own forces. A water waste party was made up consisting of an engineer in charge, a chauffeur, and two gate-valve operators. The work has been carried on each summer since 1923. As there are 270 miles of main in the city, it is not possible to make a complete survey in one summer with the present organization. Work is carried on for about five months out of the year. The entire city has been investigated for leakage in three years and many districts have been surveyed yearly.

The city has been divided into three sections, Section 1 being the High Service areas; Section 2, all of the Low Service area in the southern part of the city and Section 3, the Low Service in the northern half of the city. Each section is divided into districts varying in size, depending on the character, miles of main, and consumption in that particular part of the city. Gauging points have been established at strategic points throughout the distribution system where the measurements of flow are made.

Simplex pitot tube recorders are used for making flow measurements of each district and for the subdivision work. A light Ford truck especially equipped for this work furnishes transportation. A knock-down shelter house for housing the recorder is used, which can quickly be set up or dismantled and carried about on the Ford. As the shelter house is often set up where traffic is heavy, it has been painted with a large black and white checker-board effect to aid visibility, especially at night. For making definite locations of leaks, electric leak locators, aquaphones, test-bars and the other usual equipment is used.

Practically all of the work is carried on between the hours of 12:00 midnight and 5:00 A. M., these being the hours of minimum consumption, greatest convenience in making "shut-offs," and the quietest hours for listening with the leak locating instruments. As the city is nearly 100 per cent metered, it is not necessary to carry the investigations into houses, which are seldom using water during these hours.

The night rate of a district is first determined by setting up the pitot recorder over a 6" or 8" main at one of the gauging stations and isolating the district by closing all district boundary valves except the one ahead of the meter. The linear velocity in the pipe is recorded on a circular chart, from which, knowing the constants of the gauging station, the flow thru the pipe is readily

* Engr. Water Waste Survey, Syracuse, N. Y.

computed. Whether this rate is excessive or not is judged by the size of the district, the number of probable night consumers, and previous records of the district if any are available. If the consumption is low, the boundary valves are opened and the recorder set up in another district. If it is higher than it should be, the district is subdivided to determine the distribution of the night rate as to metered use, leakage, unmetered use (such as fountains, horse troughs, etc.) and small evenly distributed leakage and metered use.

A district is "subdivided" by beginning at the boundary and cutting the isolated area out block by block by closing the valve or valves at the "inside" end of a boundary block, and opening the original boundary valve at the other end of the block. The boundary line is thus pulled into the district so as to exclude the main in that block. If that block has an appreciable consumption, it will be recorded on the chart by a drop in velocity thru the main at the gauging station In this manner the entire district is "cut out" block by block, or in larger sections if the valves are few, until the meter records only that consumption in the block in which it is set up. The rate of consumption of each subdivision is therefore known.

Knowing the rate of flow in each subdivision, the next thing is to account for the distribution of that rate. The practice in Syracuse is to investigate rates not lower than 20,000 g. p. d. per average city block, unless there is known to be leakage which is causing some particular damage. If there are any factories or other large users in the subdivision which are operating during the night hours, rates of consumption are taken on the meters just before the "shut-off" is made. This constitutes a rough check on the meter if there is no other use or leakage in the subdivision. Where it is convenient to shut-off the service to such a consumer, a more reliable check of the accuracy of the meter is obtained.

If there is no metered use in the subdivision, or if the "drop" on the meter shows a greater flow than that thru the meter, the main and services in the shut-off are tested for leakage. Gate valves and hydrants are tested with aquaphones to detect the leakage noise, and the relative magnitude of the sound gives an indication of the nearness of the leak. Electric leak locators employing the use of a microphone are then used on the ground or pavement to locate the leak accurately enough for digging. Listening on top of service boxes with the microphone is the method used to determine if leakage exists on the service pipe.

If a leak is heard in this manner, the cover of the box is removed and the service tested with the curb key to determine on which side of the curb-box the leak is.

Every help available is used for definite leak locations, as false locations are expensive, especially where it means a cut in the pavement. Useful information is obtained by observing the flow in sewers and depressions in pavements. Where leakage water enters underground cable ducts, helpful information may be obtained by a study of the flow in these ducts and the manholes between which they run.

By far the most valuable aid in leakage work in this city is the electric leak locator. Many leaks which cannot possibly be located in any other way are found with this instrument. Although not infallible, in the hands of a skillful operator it will bring results where many of the ordinary methods fail. This is especially true in locating dead service leaks where the location of the service itself is not known.

Leaks in main joints and in services are found wasting as high as 125,000 gallons per 24 hours. Most of the leaks, however, vary from 20,000 to 60,000 g. p. d.

The following table is typical of the distribution of the night rate of a district:

| | | | |
|---|---|---|---|
| Total night rate ..... | 340.000 | g. p. d. | 100% |
| Metered use (read on meters).. | 68,000 | " | 20% |
| Located leakage ..... | 85,000 | " | 25% |
| Use and waste (fountains, etc.) | 51,000 | " | 15% |
| Unaccounted for ..... | 136,000 | " | 40% |

The flow unaccounted for includes small leakage, small metered use in houses and leakage which could not be located. Generally this item is evenly distributed over the whole district.

Although the Syracuse water system is of the gravity type, is nearly 100 per cent metered, and is not experiencing a shortage of water, the money used in water waste investigation is considered well spent as such work tends to keep the consumption at a minimum. This not only delays the investment in conduit capacity but also makes the storage reservoirs more effective in the event of breakdowns in conduit service. Systematic detection and repair of leakage saves the undermining of pavements with expensive repairs. Not all loss of water is leakage or waste. In a few instances large losses in districts have been traced to the use of unmetered fire services where employees have carelessly left cross-connection valves open or have tapped fire lines by mistake.

The reduction of leakage and waste, however, is not the only valuable feature of this work. Much valuable information is obtained concerning the physical condition of the distribution system. As most of the valves in every district are operated in forming district boundaries and in subdivision work, the operating condition of each is observed and all defects are promptly noted and reported to the maintenance department of the bureau for repairs. No other gate valve inspection is deemed necessary. Hydrants too are necessarily used to some extent and needed repairs are noted. Many other features of this work include inspection of "cross-connections" and services in factories, accuracy checks of large meters, feeder flows, map connections, and other general inspection work.

Many interesting incidents have occurred in carrying on the work. The surveys have also revealed facts concerning the system which might never have come to light.

A serious condition in a downtown office building was discovered one night when an attempt

was made to shut-off a block on which this building fronted. When a hydrant was opened to see that the valves were not leaking, it was found that a substantial pressure still existed in the main. From previous experience it was evident that the pressure was either due to "backwater" from the high buildings or thru interconnected services from a parallel street. As the hydrant flowed freely under good pressure, it was obvious that the latter was the case. The parallel street was therefore shut-off and the hydrant again opened. This time, however, the pressure soon dropped but to the surprise of the writer and his party, steaming hot water began to flow from the hydrant. The hydrant was quickly closed, the water turned on and a search instigated in the block to find the origin of the hot water. After some delay in gaining access to one of the office buildings, a highly excited fireman was found who stated that he had lost nearly all of the water in his boiler in record time. An investigation of the piping in the building showed that there were two large services, one from each street, which were connected together ahead of the meter and were not equipped with double check valves. The check-valve on the boiler feed line was found to be stuck wide open.

The movements of the water waste party on the front lawns in the small hours of the morning have frequently excited the suspicions of insomniac persons who were observing from behind partly drawn shades resulting in calls to police headquarters. The police patrol would soon appear only to retire in disgust when they learned the suspected burglars were on the city payroll. Once the night crew were mistaken for highwaymen and once for auto thieves.

No large fires have ever occurred in a district while it has been isolated for measurement or subdivision work. At the first sound of the alarm bell or approaching fire apparatus, the district is opened at several points insuring ample feed and the party immediately afterwards stands by at the fire to be of service if needed.

## A California Joint Sewage Outlet

Joint construction and operation of sewerage structures is not as common in the western states as in the eastern, probably because in few localities are large communities grouped together sufficiently close to make this practicable or desirable.

Arrangements have recently been made, however, for such cooperation between adjoining cities of Los Angeles and Santa Monica, California. The idea has been under discussion between the two cities for some time, during which it has undergone certain modifications, and at last a contract has been entered into for the construction of a joint trunk sewer and outlet. This will receive all of the sewage from Santa Monica and that from a large part of Los Angeles. A joint trunk sewer will carry the sewage to an outfall into the Pacific Ocean at Hyperion.

The joint sewer will carry the sewage from both cities by gravity to a pumping plant at Venice (which was annexed by Los Angeles a year or two ago). Here it will be pumped through a force main 9,000 feet long to the outfall; this force main being of 30-inch pipe in which there will be a maximum pressure of about 50 pounds per square inch. This pumping will permit abandoning the Venice outfall, while the Santa Monica outfall will be retained but used for emergency only.

Under the contract Santa Monica will build that portion of the sewer which lies within its territory, while of the cost of the balance, including the pumping plant, Santa Monica is to pay 65 per cent and Los Angeles 35 per cent; except that Los Angeles will also pay $10,000 of Santa Monica's 65 percent to compensate for some extra deep trench made necessary to receive sewage from some of the low-lying territory in Venice.

# Tri-State Compact Re. the Delaware River

**A compact agreed upon by representatives of New York, New Jersey and Pennsylvania for apportioning the waters of that river and for protecting them from pollution and the water shed from forest fires.**

The Delaware river rises in the state of New York, where it has a drainage area of about 2390 miles, flows in a general southerly direction forming the boundary between New York and Pennsylvania as far as Port Jervis, beyond which point it forms the boundary between Pennsylvania and New Jersey, it and its tributaries having a drainage area of about 1980 square miles in New Jersey and 6076 square miles in Pennsylvania. It forms the source of water supply for a number of cities and smaller communities along its course; receives the sewage, either treated or untreated, from all of them, and furnishes power at a number of points. Tide water sets back occasionally nearly or quite as far as Trenton, although the effect of salt water is seldom appreciable as far up as Philadelphia, which city takes part of its supply from the river.

The requirements of all three states for water for potable and commercial purposes, and the complication of mutual rights and obligations in connection with the river and its watersheds have made it more and more necessary during recent years that the three states come to some kind of understanding concerning the use of the river, so that each might use to its fullest extent the advantages of the river insofar as it was entitled to them without infringing upon the rights of the other states.

Early in 1923 the legislatures of the three states authorized their governors to appoint commissioners to consider the situation. Pennsylvania was represented by Dr. Chas. H. Miner,

commissioner of health, Robert Y. Stuart, secy. of forests & water, and Philip P. Wells, deputy attorney general; New Jersey was represented by W. A. Starrett and Frederick C. Schneider; New York by George MacDonald, Rudolph Reiner and Jefferson De Mont Thompson. The outgrowth of their deliberations was a compact in accordance with which the rights and obligations of the three states to the water of the Delaware river would be defined. In the drafting of this compact the commission was advised by the attorney generals of the three states and by engineers, Thaddeus Merriman, chief engineer of the New York Board of Water Supply, acting as consulting engineer, while Col. John R. Slattery of the Corps of Engineers and Col. Wm. Kelly of the Federal Power Commission, represented the United States Government. The consent of the Federal Government to any treaty needs to be obtained, since the Delaware river is a navigable stream over a considerable part of its length.

The compact so drawn up had no effect, of course, unless ratified by the several state legislatures, and only the New York legislature ratified it, objections being found by those of the other two states.

Fortunately, the commission was not discouraged by this rejection of the compact, but has endeavored to draw up another one which it hopes will meet with the approval of the three legislatures. The commission retained the same membership so far as Pennsylvania and New York are concerned, but the state of New Jersey appointed entirely new commissioners, there being seven in place of the original three; these seven being Willard I. Hamilton, Henry G. Parker, Harry Bacharach, S. W. McClave, C. P. Bassett, F. Morse Archer, and Edward L. Young. On January 13th these commissioners signed a new compact, to be presented to the state legislatures of the three states at the sessions beginning in the month of January, 1927.

The new compact is very similar to the old with several minor changes and one or two very important ones.

According to the first compact, each of the three states was entitled to one third of the water flowing in the river at the point of intersection of the three state lines (which is near Port Jervis), exclusive of a reserve flow equivalent to 0.15 of a cubic foot per second for each square mile of drainage area above the point of diversion. Below this point, where the river forms a boundary between New Jersey and Pennsylvania, each of those two states would be entitled to one-half of the water originating within the drainage area below the New York-New Jersey state line over and above a reserve flow of 0.18 of a cubic foot per second per square mile of drainage area. In figuring these quantities, the amount allotted to each state was to be diminished by any water which was being diverted by that state or citizens of that state at the time the compact went into effect.

In the new compact, the amount of water which each state can divert from the river is over and above "all quantities of water which have heretofore been lawfully diverted by the normal operation of all works existing and in actual operation within each state in the Delaware drainage basin when this compact becomes effective, and the future diversion of water in quantities not exceeding those heretofore lawfully diverted by the normal operation of such works shall not be charged against the total quantity which may be diverted under authority of this article by that signatory state in which said works are located."

Moreover, instead of each of the three states taking one third of the flow at Port Jervis, and New Jersey and Pennsylvania each taking one-half of the runoff below that point, according to this year's compact Pennsylvania will be entitled to 328½ billion gallons per year, or an average of 900 million gallons daily; New Jersey and New York each to 219 billion gallons, equivalent to 600 million gallons daily; to be diverted from the river or any tributary within its own boundaries.

Provision is made for the creating of a Tri-State Delaware River Commission as "a body corporate to consist of not more than three members from each of the signatory states" to carry out the provisions of the compact when it shall be signed and become a treaty. This commission shall, from time to time, prescribe schedules for diversion, and must allot to each state at least one third of the flow over and above reserve flow requirements above Port Jervis and to each of the two states at least one half of the flow over and above reserve flow requirements; and may allot more than these amounts to any one state should the other states not demand the same, but with the understanding that its share may be reduced to one third or one half whenever it may become necessary.

On every tributary from which a diversion is made there must be provided sufficient storage to insure the reserve flow of 0.45 of a cubic foot per second for each square mile of drainage area above the point of storage, at all points above Port Jervis; and below this point, a reserve flow equal to 0.15 of a cubic foot. Where no storage is necessary to insure this reserve flow none is required, but if at any time the flow of the river should become less than this and there is no storage, no diversion of water will be permitted.

In addition to these reserve flows, there must be left in the river any amounts of water which may have been developed by storage and are utilized at a point below the reservoir, such water being known as "water in transit" in the channel of the Delaware river; but the daily rate at which "water in transit" may be removed from the channel shall not exceed the daily rate at which it is delivered.

Water developed by the construction of dams or otherwise may be carried outside of the Delaware drainage basin for use by the signatory states, but not for use outside of those states; nor can one signatory state grant or dispose of to another signatory state any of the water alloted to it except by legislative act.

In making allotment, the importance and public value of water is classified in the following order; (a) Use by or for waterworks serving the public; (b) The conveyance of sewage and other waste; (c) For manufacturing and industrial purposes and for the generation of energy, directly or indirectly; and (d) For transportation and operation of water craft.

Provision is also made for preserving the sanitary quality of the Delaware river water, the states agreeing to cooperate in carrying out a policy for maintaining said waters in "a sanitary condition at least equal to that which obtains as of the date when this compact becomes effective." Also, for securing more uniform stream flow, each state agrees "to adhere to a policy covering the establishment and maintenance of an adequate forest cover in the Delaware drainage basin and the maintenance of the highest practicable standards of protection from fire on these lands."

One of the important results of this compact, and the one which, perhaps, is uppermost in the mind of the public at large, is the fact that under its provision the cities of Philadelphia and New York can use the Delaware river for public water supply, as can also the metropolitan districts in New Jersey opposite those cities.

Should the treaty be ratified by the three states, it may be presumed that New York City will build a reservoir in the valley of the Neversink near Port Jervis, in which the water would be more than 500 feet higher than the city and so could be brought to it and distributed by gravity, although this would probably necessitate a tunnel under the Shawangunk mountains and under the Hudson river.

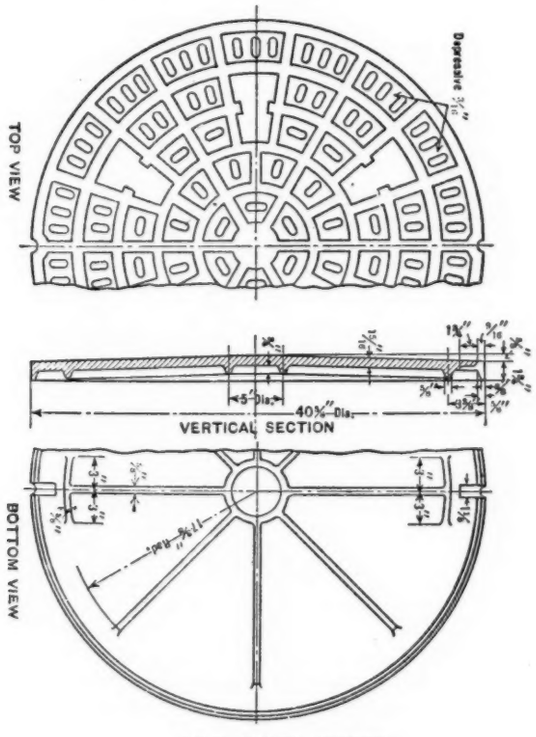
# Tests of Manhole Covers

**Actual tests of old covers and of new designs with a view to securing the most economical.**

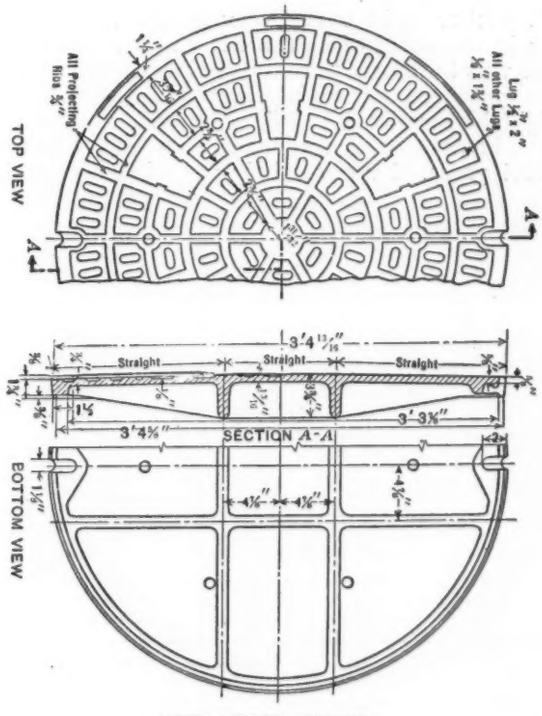
The Division of Civil Engineering of the Pacific Gas & Electric Company has made a report to the company discussing the theoretic stresses and deflections of manhole covers as compared with the values obtained by tests; this investigation having been brought about by a request of the Division of Electric & Steam Distribution of the company for a change in the design of the manhole covers which would result in a saving in the initial cost and increased strength to conform with present traffic requirements. A resume of this report was presented to the American Society of Civil Engineers by T. J. Corwin, Jr., assistant engineer of the Pacific Gas & Electric Co., of San Francisco, Cal., and published in the January "Proceedings." An abstract of this paper is given below.

The strength of the covers used by this company had never been determined by tests, nor were any data found which had been obtained by tests made by others which would answer the questions involved. The company uses two kinds of covers, one solid, the other ventilating through slots that occupied nearly half the area.

A study of the design of the old ventilating cover indicated that a reduction could be made in the weight, for the two systems of ribs employed were not of equal strength and as the weaker was apparently strong enough, the other




OLD SOLID COVER.




NEW SOLID COVER.

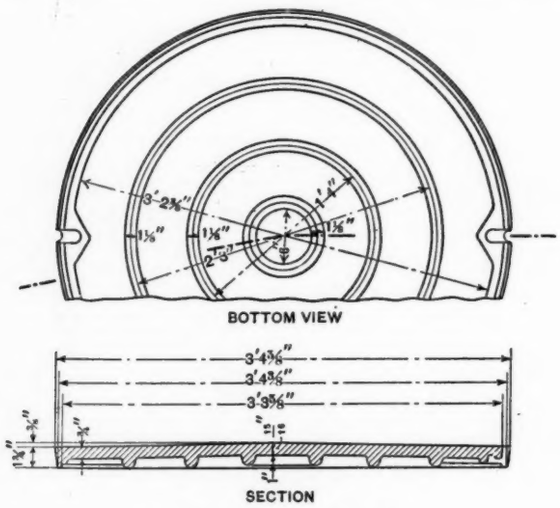
would apparently be unnecessarily strong. Moreover, the ribs were of constant thickness for the full width of the cover, whereas a varying thickness with reduced weight would be equally as strong. This condition did not obtain, however, with the solid cover.

In studying the new designs, a load of 15,000 pounds plus an impact factor of one third was assumed as the working load. On this basis the covers were designed for an ultimate load of 70,000 pounds. An effort was made in preparing the design to keep the weight of the cover and its consequent cost at a minimum although the minimum thickness of casting advisable was the factor that really established the final weight, after the strength requirement had been satisfied.

There seemed to be but three systems of designing ribs which could be used, radial ribs, concentric circular ribs, and a system of rectangular ribs. It was evident that from consideration of strength alone, all ribs should be on top of the cover since the tensile strength of the metal was less than half its compressive strength. However, deep ribs on top would be objectionable. Crowning the cover without ribs would also be objectionable to traffic, while "placing ribs on the bottom would seem to defeat the purpose in view in adding them. According to the theory of flexure, the fibre stress is proportional to the distance from the neutral axis. The distance to the extreme fibres in tension will be two to three times the distance to the extreme fibres in compression. This does not seem to be an economic design. However, a cover was designed with the plate thickness the same as the old design (which had proved satisfactory as to strength) and four ribs were added on the bottom, two sets of two, at right angles.

"Another solid cover was designed with the ribs in the form of concentric circles. This design was based on the assumption that contraction occurred on radial lines and the stresses might be equalized in this manner."

The actual test was made in a 300,000 pound wheel press, the cover being set in a manhole




SOLID RIBBED COVER.

head and the head itself adjusted in the press so as to make the pressure of the ram of the press normal to the cover. The lower side of the cover and its seat in the frame were machined to insure a uniform bearing. Pressure was applied through a cylindrical loading block at the center of the cover. Extensometers were used and Ames dials indicating deformation to the nearest 0.001 inch.

Solid covers of cast steel were taken from service for testing, and also new standard covers of semi-steel were tested. Concerning tests of the latter the author says: "1. The results obtained by test agree fairly well with the theoretical values; the maximum fiber stress in tension agrees with the ultimate tensile strength of the metal. It was very difficult to obtain the fiber deformation with the equipment at hand and the tests had to be made a number of times before the results proved satisfactory. *2. Concentric circular ribs.* As the covers did not meet the requirements for ultimate strength, no attempt was made to check the stresses in the plate. 3. *Old Standard.* The ultimate strength was the only value desired for this cover." A tabulated comparison of the unit stresses as measured and as computed is shown in the accompanying table.

In testing the design adopted as a new standard, "failure occurred either along one of the ribs or at an intersection of the ribs. The intersections of the ribs were readily located by depressions in the top of the cover. After failure had occurred, inspection showed that the properties of the metal at the intersection were different from those of the main mass, by a marked change in color. All covers failed in practically the same manner. Considering the relative weakness of the ribs in tension, one would expect the cover to fail across the diameter at right angles to a set of ribs. This was almost the case, except for the apparent weakness at the intersection of the ribs, for in each cover failure occurred through at least two of these points. The first cover just reached the design strength required (70,000 pounds). Other tests indicated that the cover was capable of resisting an ultimate load of 100,000 pounds and that failure at 69,000 lb. was due to a flaw of the ribs of the specimen.

"The cover with concentric ribs failed principally on radial lines, except for encircling the small central rib. With the old standard cover, failure occurred almost without exception adjacent to a rib of the cover. The first crack appeared along a rib and the rapid deflection that followed was probably the reason for failure occurring at such a small load."

"The stresses in a flat circular plate are tensile and compressive stresses along radial and tangential lines and direct shearing stresses. The shearing stress will not be considered for it will never be parallel to the main stresses caused by contraction. Considering the cover with radial ribs; when the metal cools it obviously solidifies between the ribs first, and the tendency will be to set up initial stresses between the ribs. These stresses should be normal to the bisector

of the angles formed by the ribs. Analyzing the stresses in the plate, it is found that the radial stress at the circumference is zero, but the radial and tangential stresses are equal and a maximum at the center. The tangential stress is not zero at the circumference, so it will be seen that throughout the plate the tangential stress is larger than the radial stress. It seems obvious that the sum of the two forces, one initial and the other caused by the load ,are combined algebraically and that failure occurs at a comparatively low external load.

"The cover with concentric ribs should have initial stresses on radial lines between the ribs. This is apparently true, for covers made from the same heat withstood a 50 degree greater load than the cover with radial ribs. The contraction stresses should not be of such a serious nature in a cover with a rectangular system of ribs. This is particularly true if the ribs are deep, placing most of the flat cover in compression. These ribs should cause the stress to distribute in a manner similar to the stress distribution in a square plate. The contraction of the metal at the intersection of the ribs apparently causes relatively high initial stresses and is the one weak point in this type of design. The greatest strength, however, is obtained with this design."

Consideration was also given to the use of cast iron, semi-steel, and cast steel. The ratios of ultimate strength to cost gave results of 17.0 for cast iron, 16.7 for semi-steel and 18.3 for cast steel. The difference is not great, but cast steel seems to be slightly the most economical.

**Semi-Steel Cover, Solid Type**

| Gauge, in pounds per square inch | Load in pounds | Moment in inch-pounds | Unit Stresses, in Lbs. Per Sq. In. Fuller and Johnson Computations | Burr Computations | Measured |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 |
| 165 | 9,500 | 48,400 | 3,250 | 2,810 | 2,800 |
| 265 | 15,860 | 81,000 | 5,430 | 4,710 | 4,060 |
| 360 | 21,900 | 111,800 | 7,500 | 6,500 | 5,310 |
| 460 | 28,260 | 144,500 | 9,660 | 8,400 | 5,310 |
| 555 | 34,310 | 175,000 | 11,750 | 10,150 | 7,510 |
| 650 | 40,350 | 205,000 | 13,800 | 11,900 | 10,600 |
| 750 | 46,720 | 238,000 | 16,000 | 13,750 | 11,900 |
| 855 | 53,400 | 272,000 | 18,250 | 15,800 | 13,150 |

The author considers semi-steel as ideal for solid manhole covers because the cost is the same as for cast iron and the tensile strength is 50 per cent greater than that of cast iron when approximately 25 per cent of steel scrap is included in the melt. The new covers have been in service for more than two years and no failure has been reported.

## Municipal Bonds Underpriced

The municipal bond business has grown tremendously since the World War. From the standpoint of volume it is second in importance only to public utility finance and this position it is likely to hold indefinitely. At the moment, the trend of municipal borrowing is down, the post-war peak apparently having been reached two years ago. Borrowings on long term bonds in 1925 showed a drop of $40,000,000 as compared with the preceding year, and the 1926 figure is smaller than 1925 by about the same amount. Just how far the decline may go is a matter of opinion. A study of the normal demand and the normal growth of the thousands of cities, towns, and other political subdivisions of the country, however, suggests that the annual volume of municipal borrowing will never again be much smaller than it has been, on the average, over the past five years. In this connection, consideration must also be given to the clearly apparent tendency of the taxpayers to authorize use of public credit in financing projects which are, strictly speaking, not governmental undertakings. The building of the Moffat Tunnel at a cost of some $12,000,000 raised through the sale of district bonds; the elaborate plan of the Port of New York Authority; the New York City subway system and the street railways in Chicago, are a few illustrations. Development of the benefit assessment theory of taxation and borrowing against revenues derived from publicly owned properties is also destined to play an increasingly important role in swelling the volume of State and municipal borrowing.

Competent authorities agree that municipal bonds are currently under-priced and, as investors awake to this fact, sales resistance will quickly disappear.

*(From the "Bond Buyer").*

# Roadside Tree Planting

**Synopsis of laws of all the states relative to planting and maintenance of roadside trees.**

The subject of tree planting along roadsides to increase the attractiveness of the road, and also in some cases to add to the durability by preventing excessive evaporation or other objectionable effects of sunlight, has been the subject of legislative action in a number of states, although the majority have no laws upon the subject. These latter are Alabama, Arizona, Arkansas, Colorado, Florida, Georgia, daho, Indiana, Kansas, Kentucky, Louisiana, Mississippi Montana, Nevada, New Mexico, North Dakota, Oklahoma, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, Washington and Wyoming.

In those states which have laws effecting a greater or less control of the planting and maintenance of roadside trees, the regulations of no two are alike. A synopsis of the laws that have been adopted in the different states is given below:

California—The State Highway Commission protects, permits, or plants on State roads. An application is made to this commission, and with the approval of the division engineer the State forester recommends the kind of tree and method of planting, the applicant bearing the cost of planting and care the first year, and either doing the work himself or reimbursing the State for it, after which the State assumes the responsibility. Supervisors may appoint a county board of forestry of five members, one from each supervisory district, to serve

without pay; their duties are to define policies, make rules and employ foresters, and to supervise rather than initiate planting and care on the roads not under the State highway system.

Connecticut—The State highway commission may within two years from completion, cause trees to be planted at intervals of 30 to 50 feet on trunk lines or other State-aid highways outside the cities, boroughs, or villages, if physical conditions make it practicable. Where there is no park commission, a tree warden appointed by the town selectmen has care and control of all shade trees on the other highways and may plant and remove trees. Notice of the proposed removal of a tree must be posted for five days before taking action and a hearing given concerning it when requested in writing. A bounty of 25 cents per tree per annum for five years is allowed for a few specific varieties planted not more than 60 or less than 40 feet apart.

Delaware—The State highway department is authorized to set out and preserve trees where desirable along right of way of State roads.

Illinois—The electors at the town meeting may offer premiums to induce planting along highways and to protect and preserve the trees.

Iowa—Hedges or shrubbery must be cut to within 5 feet of the ground every two years, unless needed for windbreaks, which shall not be more than 40 rods long. Supervisors may remove excess growth at the expense of property holders, except evergreens, oaks, walnuts, maple or other hardwood trees that they deem advisable to permit to stand or any part of a forest extending more than 5 rods from the road line, or groups of trees not exceeding 10 rods.

Maine—Tree wardens care for, plant, and mark trees that should be under public control.

Maryland—Roadside trees are supervised by the State department of forestry, which issues permits to cut or trim, the work to be done under the supervision of a tree warden. On unimproved roads the abutting landowner has the right to cut trees on the roadside for his own use. A roadside tree is defined as one 3 or more inches in diameter measured 3 feet from the ground, growing in the right of way of a public highway or between the curb lines and property lines of any street in an incorporated town in the State. It is further provided that trees planted by forest wardens automatically become roadside trees though less than 3 inches in diameter. No advertising signs are permitted within the right-of-way of public highways except direction signs, which, by permit, may carry advertising.

Massachusetts—Responsibility for the planting, care, and cutting of trees, shrubs, and other growths rests with the State highway commissioner for state roads and with an elected tree warden for other places except a city, which may designate a park commission, city forester, or street superintendent to act. Trees more than 1½ inches in diameter shall not be cut even by a tree warden without at least a week's notice of a hearing except for the safety of the road, but they may be cut by the State highway commission.

Michigan—The State highway commission and the State board of agriculture have joint supervision of planting trees on trunk line and other highways with the consent of property owner; under another act the State highway commission may protect growth on State-aid roads and plant any trees they can secure without buying. A tax rebate of 5 cents a tree for five years is given for private planting on roads where there has been no State reward. Trees for all planting shall be 60 feet apart and from 23 to 25 feet from the center of the road and may be obtained from the public-domain commission or the State agricultural college. No signs are permitted on trees.

Minnesota—This State has no law for planting, but has a law permitting the cutting, after notice and opportunity for the owner to be heard, of roadside willows, whether injurious or not, or of other trees or hedges if they interfere with road maintenance or cause snowdrifts. The responsibility for the execution of this law lies with the supervisors for town and county roads, county boards for State-aid roads, and the commissioner of highways for trunk lines. This negative law has recently superseded a positive tree planting law.

Missouri—The county highway engineer and the road overseers shall protect all fruit, shade, and ornamental trees along the sides of the public roads and shall remove all signs from trees.

Nebraska—Owners may plant trees at a distance not exceeding one-tenth of the width of the road from its edge. The electors at the town meeting may take action to induce the planting and cultivation of trees along the highway and to preserve and protect those standing.

New Hampshire—Mayors of cities, selectmen of towns, and county commissioners for unincorporated places, each August or September, shall remove growths that may be injurious to the road or objectionable from an artistic standpoint, but shall preserve trees marked by tree wardens or owners of adjoining property as shade or fruit trees and banks or hedges of bushes that protect the road or add beauty to the roadside. With prescribed disks the tree warden shall mark trees for shade and ornament along the highways. If the consent of the adjoining owner is given or no objection is made within 30 days, the tree becomes the property of the town; or, if opposition is encountered, it may be purchased or condemned. The State forestry department is to raise trees for roadside planting, and the State highway department may plant State highways from maintenance funds, while tree wardens may plant on other roads from funds available to them.

New Jersey—It is permissible for cities, towns, boroughs, and townships to control roadside plantings through shade-tree commissions, while the State highway commission controls planting on State highways.

New York—The town superintendent of highways may permit planting 8 feet from the edge of a 3-rod road and 1 foot farther for each additional rod of road. Elms shall not be planted closer than 70 feet, and other trees 50 feet apart, with a bonus of $1 at the end of the year for three living trees with efficient guards. He may also plant and care for trees along the highways if the town board appropriates sufficient money, or a tree warden may be appointed to perform these duties. The State highway commission has indirect control of the trees on State highways.

North Carolina—The State highway commission regulates and may cooperate with county, township, and district road authorities in the selection, planting, and protection of roadside trees. Cooperation with the State forestry department was formerly part of the law, but, unfortunately, it has recently been omitted.

Ohio—The State highway commissioner may permit private owners to plant on State Roads, while the county surveyor has the same authority for county roads and the township trustees for township roads. Planting plans may be included as a part of road improvement, and the State highway commissioners, county commissioners, and township trustees may plant from road funds; as also the State college of agriculture with funds available for forestry work.

Oregon—Pruning or removal is done under permit from the State highway commission. Planting roads over 50 feet wide on United States reclamation projects is subject to control by the county court.

Pennsylvania—Townships with a population of 300 per square mile (practically suburban sections) may establish a shade tree commission with power to plant and assess the abutting properties. In other townships no trees or shrubs may be removed along roads that run through cultivated lands, or in unimproved lands, or trees over 4 inches in diameter and more than 15 feet from the middle of the road without the consent of the property owner, unless they are impeding traffic.

Rhode Island—The tree warden supervises and initiates care and planting.

Vermont—Tree wardens are elected in towns and villages to select, mark, and protect desirable existing trees and roadside growths, to remove undesirable ones, and to regulate or plant additional trees or shrubbery groups.

West Virginia—The county engineer may issue permits for the planting of trees along county district roads at the expense of the planter.

Wisconsin—Trees may be planted under advice of the county rural planting commission, native plants to be used largely.

# NEWS OF THE SOCIETIES

**Feb. 7-8**—ROCKY MOUNTAIN SECTION, AMERICAN WATER WORKS ASS'N. Meeting at Denver, Colo.

**Feb. 16-18**—ASSOCIATION OF STATE HIGHWAY OFFICIALS OF THE NORTH ATLANTIC STATES. Third annual convention at Atlantic City, N. J.

**Feb. 21-22**—AMERICAN CONCRETE PIPE ASSOCIATION. Annual convention at Chicago, Ill.

**Feb. 21-22**—COUNTY ROAD SUPERTENDENTS OF ONTARIO. Annual conference at Toronto, Ont.

**Feb. 22-24**—AMERICAN CONCRETE INSTITUTE. Annual convention at Chicago, Ill.

**Feb. 23-25**—ONTARIO GOOD ROADS ASSOCIATION. Annual meeting at Toronto, Ont.

**March 2-4** — CANADIAN SECTION, AMERICAN WATER WORKS ASS'N. Meeting at Ottawa.

**March 25**—NEW JERSEY SEWAGE WORKS ASS'N. Annual meeting at State House, Trenton.

**April** — SOUTHEASTERN WATER AND LIGHT ASS'N. Convention at Jackson, Miss.

**May 2-4**—NATIONAL CONFERENCE ON CITY PLANNING. Annual conference at Washington, D. C.

**June 6-11** — AMERICAN WATER WORKS ASSOCIATION. 47th annual convention at Chicago, Ill.

**September**—CITY MANAGERS ASSOCIATION. Fourteenth annual convention, Dubuque, Ia.

### AMERICAN ROAD BUILDERS' ASSOCIATION

One of the largest and most successful meetings of the American Road Builders' Association was the twenty-fourth annual convention held at Chicago, Jan. 11-13. In addition to a large attendance of contractors and engineers from the United States, many foreign road builders were present. The convention was opened by an address by President H. G. Shirley, who advocated strongly a centralization of traffic control in the State Highway Departments, stating that traffic control was a necessity, and unless it were vested in highway departments, it would be assumed by other sources of authority. Other speakers at the opening session included Gov. Small, of Illinois.

The program was divided into three parts, Engineers' Section; Constructors' Section, and joint meetings. In his discussion of the relative advantages of wider highways or additional paraller highways, B. H. Petty, of Purdue University, stated that most engineers now regarded a 40-ft. pavement as the maximum desirable continuous pavement width, and where this was not adequate, it was preferable to construct parallel highways, though these did not necessarily have to be close by. Other interesting and valuable papers at this session included "Load Factor as an Element in Design," by T. W. Allen of the Bureau of Public Roads. The Wednesday morning session was largely given over to Pan-American delegates. Important papers at the afternoon session were presented by Leslie R. Ames acting highway engineer of North Carolina, and F. E. Kelly, of the Bureau of Public Roads.

The Constructors' Section covered the general problems of highway contracting. There was much discussion on estimating and cost accounting, in which completeness and comprehensiveness of data were stressed. The problem of equipment rental was discussed by C. A. Eichelberger of the Pennsylvania Department of Highways.

At the final general session, there were interesting papers by Frank T. Sheets, of the Illinois Highway Department, in "Practical Qualifying of Bidders on Public Works," and by J. L. Harrison, of the Bureau of Public Roads, "Increasing Efficiency in Highway Construction Organizations."

Officers were elected as follows: President, Charles M. Babcock, Chairman of the Minnesota State Highway Commission, Vice-presidents: Sam Hill, Washington Good Roads Association; S F. Beatty, president, Austin-Western Road Machinery Co.; W. A. Van Duser, deputy engineering executive, Pennsylvania Department of Highways; S. T. Henry, director, Pan-American Confederation for Highway Education; treasurer, James H. MacDonald, reelected.

### DAYTON SECTION, AMERICAN SOCIETY OF CIVIL ENGINEERS

Officers for the coming year have been elected by the Dayton, O., section of the American Society of Civil Engineers, as follows: President, F. J. Cellarius; vice-presidents, N. Q. Sloan, and C. H. Eiffert; secretary-treasurer, C. S. Bennett.

### LOS ANGELES ENGINEERS CLUB

This club, which was formed last November, has elected as officers: president, Frank H. Olmstead; vice-presidents, J. E. Dodge and H. L. Doolittle; secretary and treasurer, R. F. Wate.

## PERSONALS

Henry C. Allen, city engineer of Clinton, Mo., died December 20th, age 78 years.

Harvey J. Dressler of the firm of Cellarius & Dressler of Dayton, Ohio, died December 9th.

T. H. Cutler has been appointed chief engineer of the Missouri State Highway Department, succeeding B. H. Piepmeier, who has resigned.

A. H. Wieters, director of the division of sanitary engineering of the South Dakota State Board of Health, and former assistant engineer of the Kansas State Board of Health, has been appointed chief engineer of the Iowa State Department of Health, succeeding Hans V. Pederson, who resigned to become waterworks superintendent of Marshalltown, Ia.

Edwin A. Fisher, for 33 years employed by Rochester, N. Y., in engineering work, and for 18 years city engineer, retired Dec. 31, but will continue to serve the city in a consulting capacity.

W. W. Brush, for the past 17 years deputy chief engineer, Bureau of Water Supply, New York City, has been appointed chief engineer of the Department of Water Supply, Gas and Electricity of New York, succeeding Merritt H. Smith, who resigned the position a few days previous to his death.

Ray Dunlap, formerly division engineer of the Missouri State Highway Commission, has been made engineer in charge of the Bureau of Construction, succeeding Thomas H. Cutler who has been appointed chief highway engineer of that state.

W. H. Yeo has been appointed state engineer of New Mexico.

T. Chalkley Hatton, for thirteen years chief engineer of the Milwaukee Sewerage Commission, has resigned that position.

## CIVIL SERVICE EXAMINATIONS

Junior Engineer: Applications received up to February 12, 1927. To fill vacancies in various branches of the government service throughout the United States. Entrance salary $1,860 a year. Advancement after six months' probationary period depends upon individual efficiency, increased usefulness, and the occurrence of vacancies. Competitors may be examined in any of the following branches of engineering: Chemical, civil, electrical, mechanical, mining, structural steel and concrete. Duties include routine testing, material inspection, preparation of plans on minor projects, preparing specifications, performing field work, making computations, preparing maps, research, and compiling reports and handling correspondence. Competitors will be rated on general physics, mathematics, general engineering, and the optional subjects selected.

Assistant Structural Engineer: Applications received until March 31, 1927. To fill vacancies in the office of the Supervising Architect Treasury Department, and in Federal classified service throughout the United States. Entrance salary, $2,400. Possible advancement upon completion of six months' probationary period. Duties are to make, under immediate supervision, computations and designs for foundations, floor construction, columns, trusses, and similar structural features covering construction in wood, masonry, steel, or concrete, for various kinds of structures, but principally monumental buildings of the highest type, including such incidental features as retaining walls, water towers, etc.; and to prepare working drawings and check structural drawings. Non-assembled examination. Competitors will be rated on education, training, and experience.

# New Appliances

**Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations**

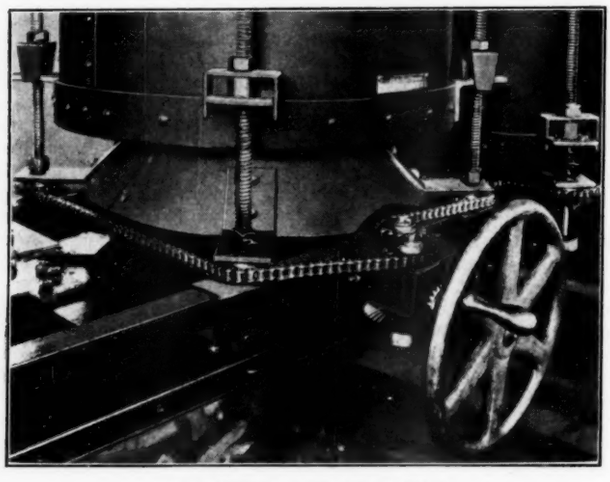
### ZONE PAINTING MACHINE

The Continental Products Co., Euclid, Ohio, manufactures a zone painting machine which has been on the market but a few months. An outstanding and unusual feature is the fact that there is absolute control of the feeding of the paint, while an adjustment screw on top which can be turned to right or left permits making either a heavy or a light line. There is no slopping for as soon as the machine stops the paint stops flowing. It is claimed that it uses less paint per mile of line than any other machine, one gallon of paint covering approximately 1,000 feet of 4-inch line. Control of the feeding of the paint is accomplished by an aluminum wheel revolving in the paint tank as the machine moves, which wheel lays the paint evenly on an endless soft rubber belt, which carries it down and applies it to the pavement. As the soft rubber belt comes in contact with the pavement it applies the paint more evenly than spraying. The machine is all aluminum and weighs only 200 pounds and can, therefore, be lifted easily on to a truck, or can be pushed along the pavement if the distance is short.

ZONE PAINTING MACHINE

### HELTZEL AGRABATCHER

The Heltzel Steel Form & Iron Co., Warren, O., manufactures an agrabatcher with a new adjusting device wherein the turn of a single control wheel raises or lowers the agrabatcher on all four supporting bolts simultaneously. The control wheel is geared on a 2 to 1 ratio. A scale is provided which shows capacities, these ranging from 8 to 14 cubic feet on the sand batcher and 13 to 28 cubic feet on the stone batcher; adjustment being possible to the ⅛ of a foot. The control wheel is located above the agrabatcher, where it can most conveniently be handled by an operator working on a platform above the truck and having full vision of his work. The device consists of a bevel gear set, and roller chain and sprockets. The makers claim that it permits of an accuracy and speed of adjustment far greater than has been secured in the past.



HELTZEL AGRABATCHER

### EUCLID SCRAPER AND TRAILER

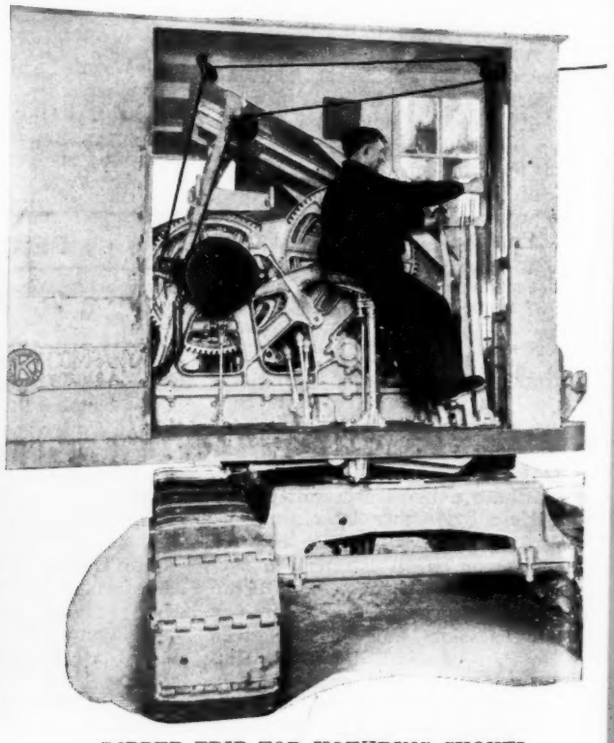
The Euclid Crane & Hoist Co., Euclid, O., manufactures a tractor scraper, which is operated by the tractor operator, thus requiring but one man. This scraper is so designed as to dig a full load without excessive draw-bar pull. The load is carried on two wheels, enabling the operator to save time by using high speed to and from the dump. The operations of loading, raising the pan, and dumping are performed by a simple and powerful hoist driven from one scraper wheel. It is possible to regulate the depth of cut by means of adjustable stops. Due to its digging rather than scraping action, the Euclid one man tractor, it is claimed, will dig more compact earth, and plowing largely can be dispensed with. It has been found practical to run a subsoiling or rooter plow through the earth to a depth of 15 to 20 inches, making furrows three or four feet apart, and then take out all material to this depth without further plowing.

The same firm also manufactures a rotary Fresno scraper. Among the advantages claimed for this scraper is one-lever control, the bite being automatically broken when the bowl is full; a hand lever controlling the depth of cut, which is valuable in fine cutting and cleaning up work.

Another product is the Euclid One-Man Dump Trailer. These are of heavy channel construction, with 1½-yard solid water tight, and 1¾-yard standard automatic end gate box, bodies. Body capacities are measured water line. Side extensions can be furnished to increase the body capacity of the standard body to 2½ yards. Bodies revolve on heavy trunnions and are dumped from the tractor seat, returning automatically when empty. The wheels are 46 inches in diameter, and have 10-inch face, with Hyatt roller bearings.

### KOEHRING DIPPER TRIP

The Koehring Company, Milwaukee, has recently brought out, as optional equipment on the Koehring heavy duty gasoline shovel, a powerful dipper trip. This is so constructed that one finger can move the lever which trips the dipper. The power for the trip cable is obtained by building a small drum, with heavy brake lining on the outside, on the end of the rear drum shaft. A second steel drum, polished on the inside and placed over the first drum, turns when there is sufficient friction between the two. The operator merely controls the friction with a lever so as to apply power to the trip cable, which is attached to the



DIPPER TRIP FOR KOEHRING SHOVEL

# DEPENDABLE

The Mark of Quality

In the power house, or on outside electrical connections — in the machine shop or garage—wherever friction tape is used—Firestone High Test and Holdfast Friction Tape meet the most exacting demands.

## High Test

—scientifically prepared—of highest uniform quality—possessing great tensile strength and gripping properties. Impregnated with special sulphur-free adhesive rubber to withstand dirt, moisture, heat and cold.

## Holdfast

—a popular priced friction tape of known quality, made in the Firestone factories at Akron, Ohio. For everyday use in store, factory or home, Holdfast has proven to be a good durable tape.

Write nearest Firestone branch or the Home Office at Akron, Ohio, for prices and specifications. Stock up with these two dependable brands, for the winter business ahead. Sold in bulk or convenient cartons.

# Firestone
## Friction Tape

AMERICANS SHOULD PRODUCE THEIR OWN RUBBER . . . Harvey S. Firestone

outside drum. The operator can trip the dipper at the exact instant it reaches the desired place. Another improvement is a slight tension on the line, there being no loose rope down in the pit when digging or over the truck when unloading.

### RYAN GRADING MACHINE

The Ryan Mfg. Corporation, Chicago, exhibited at the Chicago Road Show a new road grader with 8 to 14-foot blade for which it claims, as special new features, motor control, leanable frame, extreme lateral blade shift on frame, full circle lift arms and double reversible mold board. By motor control, a slight pull by the operator on a lever operates steel cut gears running in an oil bath by means of which the power of the gasoline engine makes the desired change in the machine. Assuming a great variety of positions and holding them firmly is made possible by an adjustable frame which swings left and right through an arc of more than 70 degrees. With two wheels in the ditch, this grader can not only right its wheels but can adjust its leanable frame to an upright position, thus transferring the weight from the downhill wheels to the wheels in the road when desired. This aids in keeping the 14-foot blade firmly in whatever cutting position has been selected. It also provides an extremely quick blade lift for use in avoiding stumps, culverts or other obstructions, the frame promptly lifting the mold board over the obstructions without disturbing its set and returns it to its previous position.

Owing to its adjustability, the machine can work eight feet outside of either the right or left wheels and can be positioned so as to carry the cut material either back to the machine or away from the machine. It can plow either under itself or outside the line of its wheels, throwing the dirt either way. This ability to work outside of the wheels enables it to do trench filling, embankment building, or mountain work where the wheels must be kept away from the declivity, and for snow removal. It can cut down a 12-foot bank and can move the material either up or down the slope as desired. The double reversible mold board provides two cutting edges and four plowing points with one board. It works with equal efficiency from either its left or its right side. The machine is offered in four blade sizes—8-foot, 10-foot, 12-foot and 14-foot length.

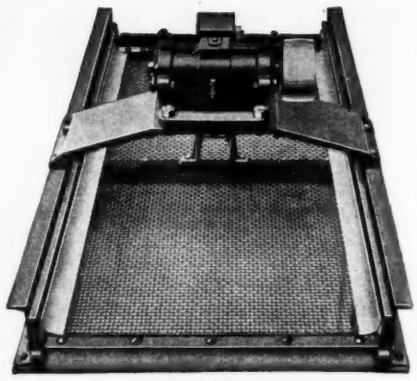
### LEAHY VIBRATING SCREEN

The Deister Concentrator Company, Fort Wayne, Indiana, manufactures a screen which it calls Leahy No-Blind Screen, suitable for screening either wet or dry material from 2½-inch opening down to 50-mesh. This includes sand and gravel, crushed stone and slag, cement, lime and many other materials. The points claimed for it are efficiency, simplicity, rugged design, reasonable cost, and economy of operation.

A wire cloth screen is held taut in longitudinal tension in a stationary frame by means of tension bolts. A quick-return differential vibration is transmitted from the vibrator cam through a connecting rod to a rigid member attached to and extending transversely across the under side of the wire screen cloth. The sides of the screen cloth are free to vibrate and the vibration is uniform at all points in a line across the screen cloth. The normal amplitude of the screen vibration is about ⅛ inch directly under the vibrator. The screen cloth at the upper end of the screen has sufficient vibration to stratify the feed material, enabling the finest to pass through the meshes rapidly. Near the middle of the screen surface a more intense vibration is present and is desirable for passing through all the particles which are just under the size of the screen cloth openings. The lower area of the screen surface finishes up the screening process, accomplishing a new degree of perfection in close sizing.

The vibration is transmitted to the screen by an 8-tooth steel cam revolving 200 R. P. M. in a bath of oil. This gives the screen about 1600 vibrations per minute, the screen cloth snapping back into position at the end of each stroke. The vibrator may be operated by a 3-inch belt or direct motor drive and requires only from ½ to 1 horse power for its operation. A spring adjustment controls the intensity of vibration and adjusts it to suit the load on the screen surface.

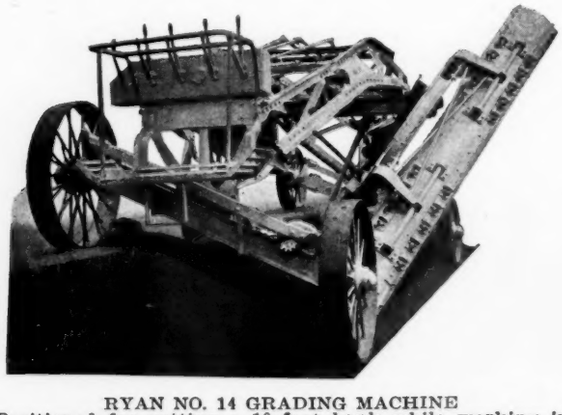
The screen cloth is held in longitudinal tension by two bolts and can be changed in five minutes. Ordinary wire mesh cloth such as is manufactured by a number of companies can be used for the screen. For sand and gravel plants a double surface screen is provided with a 1½-inch mesh on the upper deck and a 3-16-inch mesh on the lower deck. Jets of water are generally used to wash the sand through the feed on the lower screen. Double surface screens take the place of revolving screens and are claimed to have greater capacity, use less power, and give less trouble.



LEAHY "NO-BLIND" SCREEN

### MIAMI BOTTOM-DUMP TRAILER

The Miami Trailer-Scraper Co., Troy, Ohio, manufactures an all-steel four-wheel bottom-dump trailer with a carrying capacity of 2½ tons with ample factors of safety, designed from the standpoint of low cost and slow speed for tractor operation. The front gear construction provides fully for the tilting of the front wheels sideways in mounting obstructions to either front wheel. A fifth wheel provides for the full cut-under of the front wheels, which are 26 inches in diameter with 5-inch face tire, while the rear wheels are 40-inch with 7-inch face tire. The chassis frame is of 6-in. rolled steel channel weighing 10 1-2 pounds to the foot. Timken tapered roller bearings are used in the wheels to provide against end thrust of the load. The lubrication of the wheels is accomplished through Alemite nipples, making it unnecessary to remove the wheels except for the occasional clean-

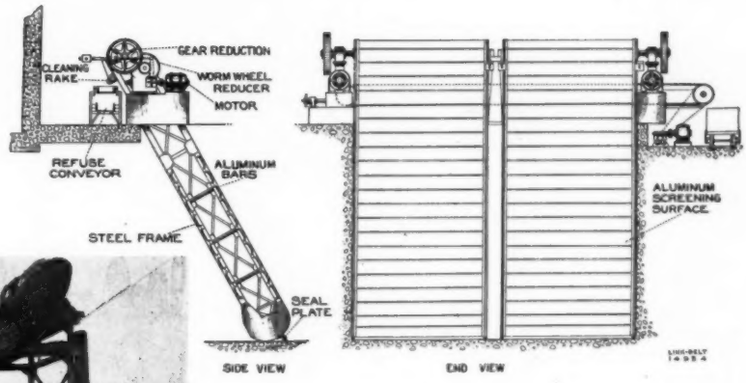


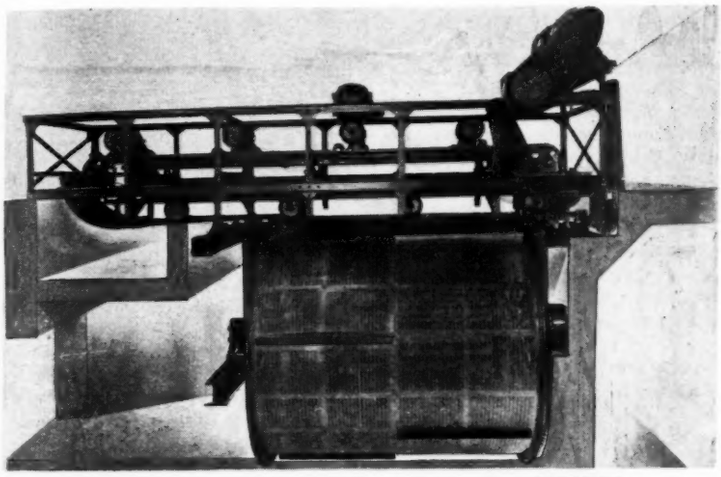
RYAN NO. 14 GRADING MACHINE
Positioned for cutting a 10-foot bank while working in a deep ditch

MIAMI BOTTOM-DUMP TRAILER

# A Page of Ideas for Economical Disposal of Sewage

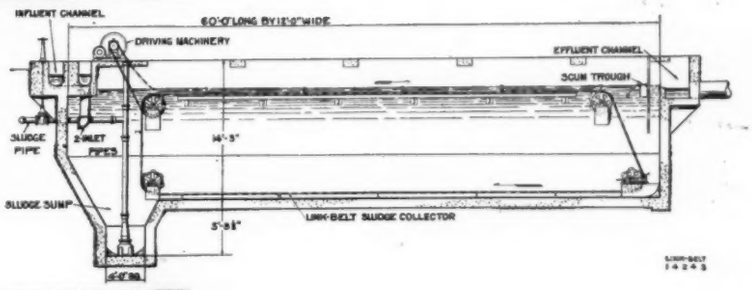
The view to the right is of the Brunotte Sewage Screen which is a mechanically cleaned coarse screen. These screens have been in use for many years in Europe. For further particulars, ask the nearest Link-Belt office.

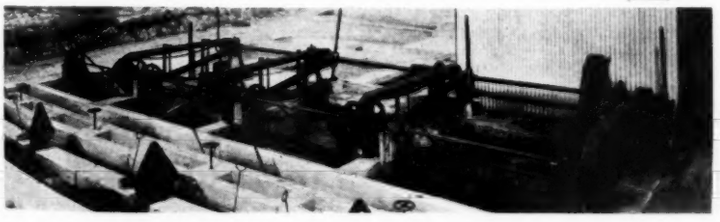


For fine screening of raw sewage use the Tark Sewage Screen. They are used in municipal and industrial plants throughout the country, to clarify the sewage before chlorination, aeration, sedimentation, or whatever may be the subsequent treatment of the effluent. It is the most efficient screen on the market for the removal of suspended solids; lowest in first cost, and the most economical in operation. Send for descriptive literature.

Link-Belt Sludge collectors are made to suit individual conditions. Their durable construction and long life; their convenient accessibility for inspection; their simple and complete efficiency—all these things make for their entire suitability to the largest or smallest plant.



The illustration to the left is of Link-Belt Sludge Collectors which have been in operation at the Sewage Treatment Plant at Gastonia, N. C., for five years without cost for maintenance.

2957

## LINK-BELT COMPANY

Leading Manufacturers of Elevating, Conveying, and Power Transmission Chains and Machinery

**CHICAGO, 300 W. Pershing Road** **INDIANAPOLIS, 200 S. Belmont Ave.** **PHILADELPHIA, 2045 Hunting Park Ave.**

Atlanta - - - - 511 Haas-Howell Bldg.
Birmingham, Ala. - 720 Brown-Marx Bldg.
Boston - - - - 1103-4 Statler Bldg.
Buffalo - - - - 554 Ellicott Square
Cleveland - - - - - 527 Rockefeller Bldg.
Denver - - - - - - 520 Boston Bldg.
Detroit - - - - - - 5938 Linsdale Ave.
Huntington, W. Va. - Robson-Prichard Bldg.
Kansas City, Mo., R.436, 1002 Baltimore Ave.
Louisville, Ky. - - - - 397 Starks Bldg.
New Orleans - 504 New Orleans Bank Bldg.
New York - - - 2676 Woolworth Bldg.
Pittsburgh - - - - - - 335 Fifth Ave.
St. Louis - - - - - - - 3638 Olive St.
Toronto 2, and Montreal, Link-Belt Limited
Wilkes-Barre - 826 Second Nat'l Bank Bldg.

H. W. CALDWELL & SON CO.:—Chicago, Western Ave., 17th and 18th Sts.; Dallas, Texas, 810 Main St.; New York, 2676 Woolworth Bldg.
LINK-BELT MEESE & GOTTFRIED CO.:—San Francisco, 19th and Harrison Sts.; Los Angeles, 361-369 S. Anderson St.; Seattle, 820 First Ave., S. Portland, Ore., 67 Front St.; Oakland, Calif., 526 Third St.

# LINK-BELT

## Sewage Disposal Plant Equipment

ing of the Timken bearings. The drawbar is constructed for attachment at any height and the trailers can be used with any type of tractor or truck and may be coupled in trains of two or more by mounting a towing hitch connector to the rear cross member of each trailer.

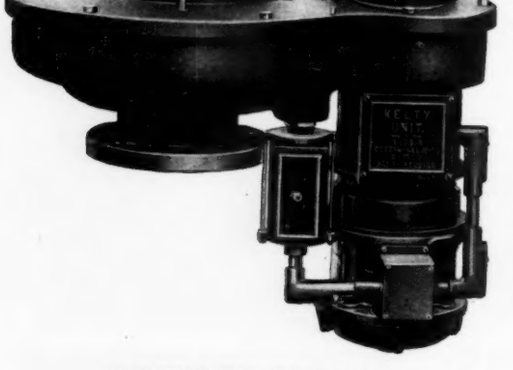
The dumping doors are hinged directly to the chassis frame or side channels, which construction results in a very low loading height from the ground to the top of the body, only 56 inches in the regular trailer and 61 inches when mounted with a five-inch top box. The dumping lever may be operated from the tractor driver's seat by means of a rope. The closing of the dumping doors is done by a winding lever placed on the right side of the trailer, which will close the door in less than five seconds.

### ELECTRIC OPERATION OF VALVES

The Coffin Valve Company, Neponset, Mass., recently placed on the market a Kelty motor drive unit adapted to the opening and closing of valves by electricity. The company states that, while a valve operated by hand or by hydraulic cylinder is completely closed during its operation, up to the present a valve operated by a motor is not completely closed by the motor; but with the limit switches which have been used formerly, the switch is set to stop the motor just before the valve is closed tight, and to make it entirely tight the wheel must be turned slightly by hand. By this new unit a valve is completely seated by the action of this motor.

A multiple disc friction clutch is introduced between the motor and the drive shaft, and on the outside of this clutch are centrifugal switches. These switches carry the electric current to the closing magnetic switch on the control panel. While the clutch is revolving, the switches are held closed by centrifugal action and maintain the current to the magnetic switch and thus to the motor; but when the clutch stops revolving—because the valve has become closed and cannot travel any farther—the switches open and break the current to the magnetic switch, which cuts off the current to the motor. The friction clutch takes up the drift of the motor after the current has been cut off. The clutch thus takes the place of the limit switch employed by other systems for stopping the motor when the valve has become closed. This method of stopping the motor is not used when the valve is being opened because the exact position of the disc when the valve is wide open is not of importance and because the clutch slips in one direction only. A stop switch is employed to shut off the motor after the valve is opened in the same manner as the ordinary limit switch.

The Kelty motor drive unit is a complete mechanism for operating a valve, consisting not only of the electrical equipment of the reduction gears, stem nut, ball races, enclosing case, etc., ready to bolt to the yoke of a valve. To apply it to a gate valve it is only necessary to remove the hand operated yoke and bolt the Kelty unit and yoke in its place. The gear reductions are so arranged that the speed of opening a valve can be varied from 6 inches to 30 inches per minute. The ratio to give the desired speed of operation between these limits can be changed at any time. Auxiliary hand operation is provided, the throwing of a lever disengaging the motor operation and engaging hand operation.



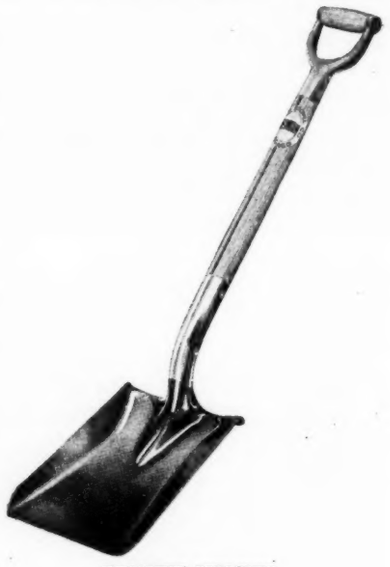
KELTY MOTOR DRIVE UNIT

### KONSET

The Sullivan Company, Memphis, Tenn., manufactures a cement and mortar mixing compound which it calls "Konset," for which it claims that it hardens and accelerates the setting of concrete and mortar, is water proof and freeze proof. Also that it gives a hard, enduring finish, prevents hair cracks, sets the bottom of concrete as fast as the top, reduces the amount of bracing needed on high forms, permits finishers to start work before the day is half over, produces ideal traveling conditions, permits early stripping of forms and bonds new concrete to old. It is shipped in containers of from 5 gallons to a barrel.

### ZENITH SHOVELS

The Zenith Shovel Company, Chicago, Ill., manufactures a shovel which it claims is a radical departure from ordinary types of shovels. Effort has been made to eliminate entirely all the weaknesses that have caused shovel failures, the handles being made practically indestructible, and the blade with special features. The handle is of tubular pressed steel, 18 gauge, with a wood grip riveter off center so that it can not turn. The handle shaft is of wood in which a slot is cut into which slot is fitted a strip of steel which strengthens the shaft and is bolted to it by 7 bolts. The blades are not welded or riveted, but blade and strap are one piece shaped from sheets. The firm makes the shovel in only one size, No. 2, with either square or round points.



ZENITH SHOVEL

### NEW MODEL FULL CRAWLER

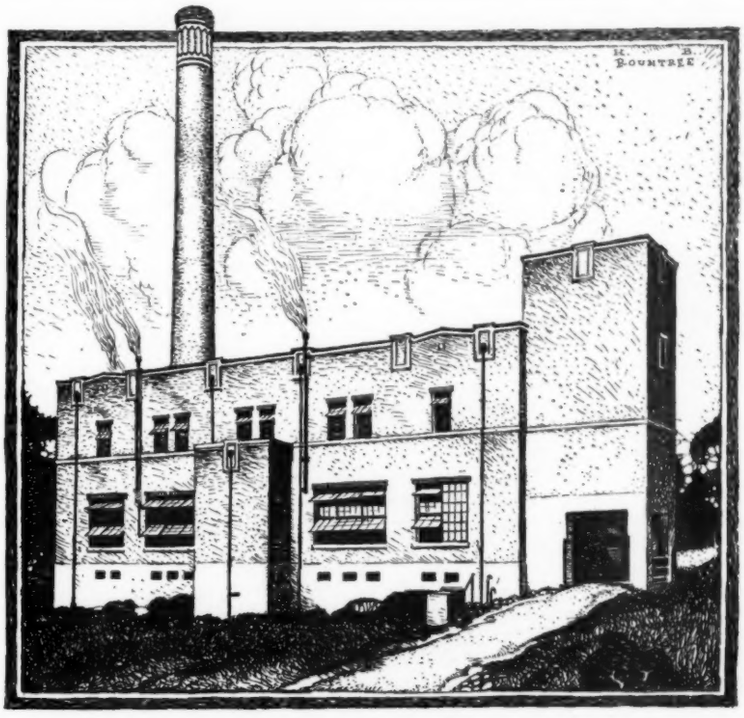
The Full-Crawler Company, Milwaukee, Wis., has just put out a new model of the Trackson Full-Crawler known as "Model D". This is a special machine built for slow, heavy pulling where drawbar pull is of prime importance, to provide a tractor between the two-ton and five-ton size. It is 75 inches wide, 120 inches long, has a rigid frame of great strength and a total weight of 4,100 pounds. It is especially adaptable for diggers, hoists, loaders, snow plows, etc. where great crowding action at low speeds is desirable. The track area has been increased to 1,600 square inches, to give it a better grip on the ground and to enable it to go over soft or rough ground.

Like the standard model Trackson, Model "D" necessitates no change in the Fordson to attach it to it. The new model will be on display at the Good Roads Show, Chicago, in Booth N. C. 24, in the new Coliseum.

HEAVY-DUTY TRACKSON FULL-CRAWLER

# DECARIE SYSTEM of INCINERATION

## *For Refuse Disposal*



*250 ton Incinerator for the City of New York, at Betts Avenue, Long Island City*

A SYSTEM for the disposal of garbage, unique in that the steel walls of the furnace are protected by a water-jacket on all sides to which the basket grate pipes are connected. Consequently the furnace becomes a steam generator, and as such furnishes, without cost, the power necessary to operate the forced and induced draft fans for the furnace. Surplus power is produced sufficient to operate pumps for water or sewage systems or for the generation of electricity.

In these plants garbage and rubbish may be fed at the same time, and the charging holes are large enough to permit objects of almost any size to pass through. In the charging operation no smoke or gas can come up through the charging hole. No fuel except the refuse itself is required.

These plants are of distinctive type and scientific design. Back of their construction is the experience of one of the oldest incinerator concerns in the United States with 70 plants in successful operation. Take advantage of this experience.

The Decarie catalogue, completely illustrated, will be of marked interest to every Municipal Engineer. A copy will be sent upon request.

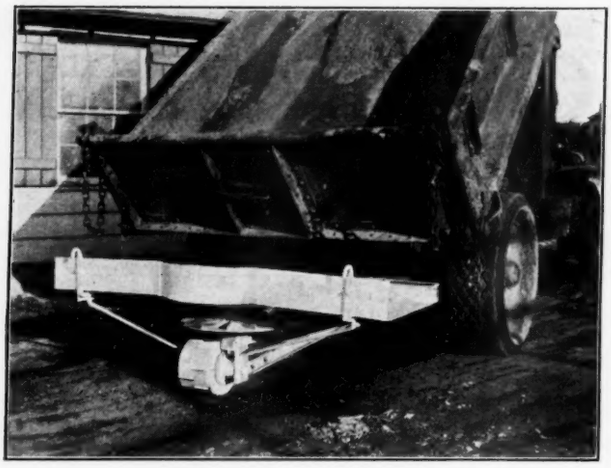
**Decarie Incinerator Corp.**

**342 Madison Avenue, New York**

**DECARIE SYSTEM**

### GOROCO CHIP SPREADER

The Good Roads Company, Inc., Upper Darby, Philadelphia, Pa., manufactures the Goroco Chip Spreader an independent unit attachable to any make of truck in one minute, which it is claimed, will do the work of twenty men at a saving of about 90 per cent on labor costs. The Goroco spreader is designed to spread any loose aggregate, such as screenings, stone or slag chips, gravel, sand or cinders, throwing it by centrifugal force from a table revolved by a wheel which rests on the pavement. The width of spread is governed by the speed of the truck and can be varied from 6 ft. to an extreme width of 20 feet. The variation in spread per square yard is controlled by a slide in the end gate of the truck, within the limits of 5 pounds minimum and 50 pounds maximum per square yard. An advantage on hot surface treatments is that the truck wheels do not touch, and consequently will not injure, the freshly treated surface, since the spreader has spread the full quantity of cover specified directly ahead of the truck wheels.



GOROCO CHIP SPREADER

## INDUSTRIAL NOTES

### ROAD SHOW

Among the exhibits at the 1927 Convention and Road Show of the American Road Builders Association were the following:

Buckeye Traction Ditcher Co.: The improved Buckeye backfiller, which, while primarily a backfiller, is also a light crane available for such uses as pulling piling, handling pipe, forms, stone, and steel, and for use with a clamshell. With convenient and easy control, this machine has a full circle swing, and adjustable length boom.

The Knickerbocker Co.: The new Knickerbocker 7-S concrete mixer, which was described in the December issue of *Public Works*.

C. D. Edwards Mfg. Co.: Road building machinery designed for use in the construction and maintenance of highways.

Climax Engineering Co.: A complete line of Climax "Trustworthy" engines, among them the model "TU" 77 h. p. engine, used on many makes of cranes, shovels, ditchers and similar machinery; the model "KU," a smaller engine; and the "R4U" and "R6U" engines.

Wausau Iron Works: The Wausau Senior snow plow, a mold-board type of plow designed especially for use in sections where the snowfall is severe and the work heavy.

Arkell Safety Bag Co.; "Arksafe" elastic paper waterproof bag linings, which may be used in cloth bags for the shipment of calcium chloride, cement, and all other granular and pulverized materials.

Sullivan Machinery Co.: Different types and sizes of the Sullivan gasoline and electric driven portable air compressors with concrete breakers, hammer drills and clay spaders; a "turbinair" portable hoist, and a road contractors' light drill sharpening machine.

Zenith-Detroit Corporation: A line of industrial carburetors of all sizes and a fuel filter recently developed by the Zenith Corporation.

Gerlinger Electric Steel Casting Co.: Carbon steel castings for use in road building and automotive work; samples of "Hard-Wear" steel, an alloy suitable for extremely hard cutting edges or wearing surfaces, such as crusher plates and bucket teeth.

Ingersoll-Rand Co.: A full line of labor saving and labor-aiding machinery for road construction and a complete portable drill steel sharpening plant in operation.

Carr Fastener Co.: Lubrication equipment and service for all kinds of mechanical equipment used in road building, including a new automatic pressure cup which provides a constant feed of lubricant into a bearing.

Bassick Manufacturing Co.: Alemite and Alemite-Zerk lubricating systems for road building equipment; also a system for handling lubricant direct from the container to the bearing.

Caterpillar Tractor Co.: Caterpillar tractors of various sizes.

Andrews-Bradshaw Co., Pittsburgh, Pa.: A section of a boiler drum with a Tracyfier steam purifier installed. The drum has plate glass ends, allowing the action of the Tracyfier in breaking up foam and supplying clean, dry steam, to be observed.

Four Wheel Drive Auto Company, Clintonville, Wisc.: A 3-ton truck with 40 x 8 pneumatic tires, cab, dump body, and hoist, and rotary snow plow.

Universal Crane Co. Cleveland, O.—Universal Crane mounted on motor truck.

The Heltzel Steel Form and Iron Co., Warren, Ohio. A very full and complete line of equipment including 35-to 105-ton trailer bins; a longitudinal joint filling machine; specially designed highways forms for use in Cuban road work; wire mesh reinforcing; curb forms; steel manhole forms; and the usual complete line of standard products, including road, curb, and gutter forms, sidewalk forms, batchers, joint builders, graders, subgrade testers, bulkheads, and mortar and tool boxes.

### SALES MANAGER OF NEW JERSEY STANDARD OIL

In accordance with reorganization plans recently perfected by the Standard Oil Company of New Jersey, Joseph S. Helm, manager of the asphalt department of the Standard Oil Company of Louisiana, becomes general manager of asphalt sales at home and abroad of the Standard Oil Compny of New Jersey. C. G. Sheffield, until recently in charge of the asphalt department of this company, has been placed in charge of sales in the lubricating department, and retires as President of the Asphalt Association, which position he has held for the past two years. In preparation for his new position, Mr. Helm spent several months during 1926 organizing asphalt sales centers in Europe.

### CATERPILLAR TRACTOR CO.

L. J. Fletcher has resigned as head of the Agricultural Engineering Division of the College of Agriculture, University of California, to become manager of the newly formed Agricultural Department of the Caterpillar Tractor Co.

### ORNSTEIN CHLORINATION PATENT

In our January issue, under the above head, we published a statement relative to the granting of a preliminary injunction against Garden City, L. I., in respect to the use of the chlorinating apparatus in its water supply plant furnished by the Paradon Engineering Co. This company now informs us that the decision was not against the Bull patent as such but more correctly against the manner in which the city was using the apparatus; that the Bull process provides for the use of comminuted iron (small pieces of iron) in the pot attached to the chlorinating apparatus, while the judge's decision says that "the evidence shows it was filled with ten-penny nails. Such nails are not what was described by Bull as comminuted iron." The Paradon company, which is licensed under the Bull patents, further calls attention to other decisions handed down in the same court in which the Garden City case was tried. On Oct. 30, 1926, motions were denied to hold the Paradon company in contempt of court for shipping several of its solution feed chlorinators using the Bull process to Seattle, Wash., and to Champaign, Ill., tthe plaintiff having alleged that the equipment practiced the Ornstein process. A motion was also denied to extend a previous injunction covering the Ornstein process so as to include chlorinating units practicing the Bull process.